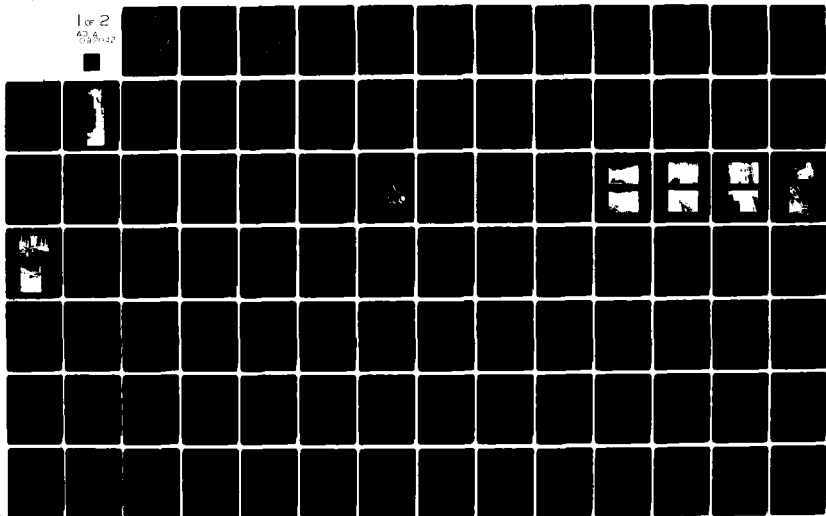


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NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13  
NATIONAL DAM SAFETY PROGRAM. GARNERVILLE DAM (INVENTORY NUMBER --E7C(U)  
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.  Examination of available documents and a visual inspection of the dam and the appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property.		

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Using Corps of Engineers screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 19 percent of Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate spillway" is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is, therefore, recommended that within 3 months of notification to the owner, detailed hydrological hydraulic investigations of the structure should be undertaken to more accurately determine the site specific characteristics of the watershed and their affect upon the overtopping potential of the dam. At the same time further analysis of the structural stability of the overflow and non-overflow section should be performed. The results of these investigations analysis will determine the appropriate remedial measures which will be required to achieve a spillway capacity adequate to discharge the outflow from at least the 1/2 PMF. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance of the structure must be provided during these periods.

On the basis of Stability Analysis performed during the investigation, the structural stability of the non-overflow section of the dam against overturning was determined to be adequate for all cases except the Extreme Loading: PMF. The structural stability of the non-overflow section of the dam against sliding was determined to be adequate for all cases except Unusual Loading: one-half PMF, and Extreme Loading: PMF.

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The following remedial measures must be completed within 1 year:

- Backfill the low saddle in the right abutment to an elevation equal to that of the top of the dam.
- Monitor the seepage of the downstream of the right abutment and through the masonry on the downstream face of the dam at bi-weekly intervals with aid of weirs. In addition determine the source of the seepage in the right abutment.
- Remove all trees on the backfill at the upstream face of the dam. Provide a program of periodic cutting and brushing of the backfill.
- Remove and haul away debris from the spillway crest.
- Remove and haul away debris and boulders from the tailrace area of the spillway immediately downstream of the dam.
- Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference. The emergency action plan described in section 7.1d should be maintained and updated periodically during the life of the structure.

8

**HUDSON RIVER BASIN**

**GARNERVILLE DAM**

**ROCKLAND COUNTY, NEW YORK  
INVENTORY NO. N.Y. 744**

**PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM**

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National Dam Safety Program  
**GARNERVILLE DAM**

**ROCKLAND COUNTY, NEW YORK**  
(INVENTORY ~~NO~~ <sup>N.Y.C.</sup> N.Y. 744)  
Hudson River Basin  
Rockland County, New York.  
**PHASE I INSPECTION REPORT,**  
**NATIONAL DAM SAFETY PROGRAM**

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## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

Recommendation For	✓	□	□	□
TIS	✓	□	□	□
TIC	□	□	□	□
Major ed	□	□	□	□
utilization	□	□	□	□
Y	□	□	□	□
Inspection by	□	□	□	□
Availability of	□	□	□	□
st	□	□	□	□
23	□	□	□	□
A	□	□	□	□
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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
GARNERVILLE DAM  
I.D. NO. N.Y. 744  
DEC No. 337 B  
HUDSON RIVER BASIN  
ROCKLAND COUNTY, NEW YORK

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PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam:                    Garnerville Dam (I.D. No. 744)  
State Located:                New York  
County Located:              Rockland  
Stream:                        Minisceongo  
Basin:                         Hudson River  
Date of Inspection:        April 24, 1980

ASSESSMENT

Examination of available documents and a visual inspection of the dam and the appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property.

Using Corps of Engineers screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 19 percent of Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate spillway" is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is, therefore, recommended that within 3 months of notification to the owner, detailed hydrological hydraulic investigations of the structure should be undertaken to more accurately determine the site specific characteristics of the watershed and their affect upon the overtopping potential of the dam. At the

same time further analysis of the structural stability of the overflow and non-overflow section should be performed. The results of these investigations analysis will determine the appropriate remedial measures which will be required to achieve a spillway capacity adequate to discharge the outflow from at least the 1/2 PMF. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance of the structure must be provided during these periods.

On the basis of Stability Analysis performed during the investigation, the structural stability of the non-overflow section of the dam against overturning was determined to be adequate for all cases except the Extreme Loading: PMF. The structural stability of the non-overflow section of the dam against sliding was determined to be adequate for all cases except Unusual Loading: one-half PMF, and Extreme Loading: PMF.

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The following remedial measures must be completed within 1 year:

- Backfill the low saddle in the right abutment to an elevation equal to that of the top of the dam.
- Monitor the seepage of the downstream of the right abutment and through the masonry on the downstream face of the dam at bi-weekly intervals with aid of weirs. In addition determine the source of the seepage in the right abutment.
- Remove all trees on the backfill at the upstream face of the dam. Provide a program of periodic cutting and brushing of the backfill.
- Remove and haul away debris from the spillway crest.
- Remove and haul away debris and boulders from the tailrace area of the spillway immediately downstream of the dam.

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- Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference. The emergency action plan described in section 7.1d should be maintained and updated periodically during the life of the structure.

*Eugene O'Brien*

Eugene O'Brien, P.E.  
New York, No. 29823

Approved By:

*W. M. Smith, Jr.*  
\_\_\_\_\_  
W. M. Smith, Jr.  
New York District Engineer

Date:

*11 Sep 80*  
\_\_\_\_\_



1. GENERAL OVERVIEW OF DAM

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
GARNERVILLE DAM  
I. D. NO. N.Y. 744  
DEC No. 337 B  
HUDSON RIVER BASIN  
ROCKLAND COUNTY, NEW YORK

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the State of New York, Department of Environmental Conservation, by letter dated 7 January 1980, in fulfillment of the requirements of the National Dam Inspection Act, Public Law 92-367, 8 August 1972.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF THE PROJECT

a. Description of the Dam and Appurtenant Structure

The Garnerville Dam is composed of a 330 foot long masonry structure that includes a 69 foot long overflow section, serving as a spillway. There are two reservoir drains, one 30-inches in diameter and one 8-inch, both are controlled by gate valves.

The crest of the embankment is 13 feet wide and the upstream and downstream slopes are 1H to 4.5V. The maximum height of the structure above the stream is 28 feet. The spillway opening, which is 6.9 feet deep, is located slightly to the left of the center of the dam and has a slightly rounded overflow crest. The 30-inch reservoir drain passes beneath the dam just to the left of the left side of the spillway and exists about 10 feet downstream of the toe. It is controlled by a gate valve located about 6 feet upstream of the dam. The 8-inch low level outlet passes slightly to the left of the 30-inch outlet and continues downstream to the town of Garnerville. It is controlled by a valve located near the toe of the dam.

The upstream slope of the masonry structure is covered with impervious clay fill and stone paving.

It is also reported and observations further indicated that the entire reservoir is lined with an impervious clay layer covered by cobblestone.

b. Location

Garnerville Dam is located on Minisceongo Creek, a tributary of the Hudson River in West Haverstraw, New York about 1-1/2 miles west of Garnerville, New York, approximately 0.75 miles north of State Route 202. The dam is in a sparsely populated residential area and directly upstream of the village of Garnerville.

c. Size Classification

The dam is 29 feet high and has a reservoir (29 feet high) with a storage capacity of 198 acre-feet and, therefore, is classified as a small dam.

d. Hazard Classification

The dam is in the "high" hazard potential category because of the close proximity of the dam to residences and its location within the town of Garnerville.

e. Ownership

Garnerville Dam is owned by the Garnerville Holding Company, 55 Railroad Avenue, Garnerville, New York 10923, Tel. (914) 947-1155, and operation and maintenance is carried out by the owner. The person to contact at the company is Mr. David Lipman.

f. Purpose of Dam

The dam was originally constructed as the uppermost of a series of dams to provide water for an industrial facility, located in Garnerville. The water is for the most part no longer used for this purpose with the exception of the 8-inch outlet which is still utilized at the company plant. Otherwise, the dam is used for recreational purpose.

g. Design and Construction History

There are no design drawings or records of the construction of the dam. The construction of the dam was completed in 1875.

h. Normal Operating Procedure

Water is continuously released from the reservoir through the 8-inch pipeline; and over the spillway through most of the year depending on the inflow. The 30-inch reservoir drain is operated periodically to check its operability and as required to lower the reservoir below spillway crest.

## 1.3

PERTINENT DATA

- |    |  |   |
|----|--|---|
| a. | <u>Drainage Area</u> (sq. mile)              | 17.5  |
| b. | <u>Discharge at Dam Site</u> (CFS)           |   |
|    | Ungated spillway at maximum pool             | 3,890   |
|    | Maximum capacity of low level outlets        | 150   |
|    | Total discharge, Maxi. Pool (El. 216.9)      | 4,040   |
| c. | <u>Elevation</u> (feet above MSL USGS Datum) |   |
|    | Top of Dam                                   | 216.9   |
|    | Maximum Design Pool                          | 210.0   |
|    | Spillway Crest                               | 210.0   |
|    | Invert low level outlets                     | 188.0   |
| d. | <u>Reservoir</u>                             |   |
|    | Length of Maximum Pool (feet)                | 1,150   |
|    | Length of Shoreline at Spillway Crest (feet) | 3,200   |
|    | Surface Area Acre                            | 10.2  |
| e. | <u>Storage</u> (acre-feet)                   |   |
|    | Reservoir at Spillway Crest                  | 100.0   |
|    | Reservoir at Maximum Pool (Top of Dam)       | 198.0   |
| f. | <u>Dam</u>                                   |   |
|    | Type   | Masonry Gravity Dam                                     |
|    | Length (feet)                                | 328.5   |
|    | Upstream Slope                               | 1H to 4.5V  |
|    | Downstream Slope                             | 1H to 4.5V -  |
|    |  | (Covered with fill and stone paving to $\pm$ 30° slope) |
|    | Crest Elevation                              | 216.9   |
|    | Crest Width (feet)                           | 13  |
|    | Grout Curtain                                | None  |
| g. | <u>Spillway</u>                              |   |
|    | Type   | Broadcrested overflow section of dam                    |
|    | Length (feet)                                | 69 feet   |
|    | Crest Elevation (MSL)                        | 210   |
|    | Upstream Channel                             | None  |
|    | Downstream Channel                           | 100 feet wide (boulders and debris in stream)           |
| h. | <u>Reservoir Drain and Pipeline</u>          |   |

Upstream: A dual intake structure is located 11.5 feet to the left of the overflow section, included is a gate valve for the 30-inch pipe, and a screen type structure. It was not possible to ascertain exact invert levels of intakes.

Downstream: The outlet for 30-inch cast iron pipe is located in a channel about 10 feet from downstream toe just left of overflow section. Control for the 8-inch pipe is near the toe of the dam 85-feet left from the center of the overflow section.

## SECTION 2 - ENGINEERING DATA

### 2.1 GEOLOGY

#### a. Geology

The records of the owner contain no data on site geology. However, there is data available in the literature on the general geology of the area. The rock in the area is the Brunswick Formation of the Newark Group of the upper Triassic. Generally, the rocks of this formation are sandstone, red shale conglomerate and limestone. No outcrops existed at the dam site to confirm the existence of this type of rock.

### 2.2 SUBSURFACE INVESTIGATIONS

No subsurface investigation could be located for the dam. However, the General Soil Map of New York State prepared by the Cornell University Experiment Station (1968) indicates that the surficial soils around Garnerville Dam are of the Rockaway-Chatfield Association. This association is dominated by well drained, moderately coarse textured sandy loams and loams on glacial till derived from granitic rocks.

### 2.3 DAM AND APPURTENANT STRUCTURES

There are virtually no records or drawings with regard to the original construction of the dam or low level outlet structures. There are a few sketches of the outlet works in the records of the owner.

### 2.4 CONSTRUCTION RECORDS

No information has been located in relation to the construction of the project. The completion is assumed to be 1875 from a Marble Plaque located on the dam. The name of the contractor is unknown.

### 2.5 OPERATION RECORD

In recent years there has been no regular operation of the dam and no records were kept of the reservoir operation. The dam is inspected on occasion by the maintenance staff of the owner but no regular maintenance is carried out, and no systematic monitoring of the performance of the dam is in effect.

### 2.6 EVALUATION OF DATA

There is little data available about the design or construction of the dam. There are reportedly some drawings with regard to the construction of the outlet works available in the records of the owner, but these, although reported, were not made available to us. Although the data is not adequate for an in-depth evaluation, estimates, field observations, measurements and discussions regarding past history and performance of the dam, supports sufficient data for Phase I evaluation.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

#### a. General

The visual inspection of Garnerville Dam was made on April 24, 1980. The weather was fair and the temperature was 60° to 65°F. The reservoir had been lowered about 1 to 2 feet to allow inspection of the spillway crest and downstream face.

#### b. Main Dam

The main dam which was completed in 1875 shows no signs of major distress or structural problems. The vertical and horizontal alignment of the crest appears to be unchanged. There are no major cracks in the masonry joints on the dam or spillway sections. However, the following adverse conditions were noted.

(1) There is minor seepage through small cracks in the masonry near the toe of the dam on the left non-overflow section.

(2) There is a low saddle on the right abutment which appears to be the result of construction activities in the area. Seepage of about 5 gpm emanates from the ground about 1,000 feet directly downstream from this point. There is no indication of fines being washed.

(3) There is a large amount of tree growth on the right non-overflow section of the dam immediately upstream of the crest of the dam.

(4) There is a zone of ice damage in the masonry wherever it is exposed to the reservoir.

#### c. Spillway and Tailrace

The downstream face at the spillway appears to be in good condition. It was difficult to observe the condition of the crest of the spillway due to the remains of the flashboard structure, which was constructed to increase the storage capacity of the reservoir. At the time of the flashboard construction, a large stair step like overflow crib structure was constructed downstream of the spillway. Both structures have since been demolished by a flood (reportedly in 1956). The spillway crest has the general appearance, therefore, of being in much poorer condition. However, between the remains of the flashboards the crest appears to be in good condition.

The tailrace channel of the spillway is full of debris from the flashboard structure, overflow crib structure, and boulders. The channel is also choked intermittently for a substantial distance downstream with fallen trees and the abutments of several old bridges.

d. Reservoir Drain and Pipeline

The regulating gates for the 30-inch reservoir drain and the 8-inch pipeline are in good operating condition and appear to be well maintained.

e. Reservoir Area

There are neither slides, rockfalls, sloughing or other signs of instability in the vicinity of the dam. There are, however, small earth slides at the eastern end of the reservoir 0.5 mile from dam. The slides are likely the result of vandals breaking apart a number of stone retaining walls built around the dam. These do not appear to present a hazardous condition. There were no objectionable amounts of floating debris in the reservoir.

3.2 EVALUATION OF OBSERVATIONS

Although deficiencies were observed there is no indication that the dam is in imminent danger. A number of the deficiencies observed in the previous paragraphs are minor and should be corrected by the maintenance forces. Other conditions described above, however, represent conditions which may have potential for further deterioration for this reason, these conditions need to be further investigated.

Significant conditions which were observed which require immediate investigation to determine the extent of corrective action necessary to determine the stability of the dam and appurtenances. The following is a summary of the problem areas encountered, in order of importance, with the appropriate recommended action:

1. Backfill the low saddle in the right abutment to an elevation equal to that of the top of the dam.
2. Monitor the seepage at the downstream of the right abutment and through the masonry on the downstream face of the dam at bi-weekly intervals with aid of weirs. In addition determine the source of the seepage in the right abutment.
3. Remove all trees on backfill at the upstream face of the dam.
4. Remove and haul away debris from the spillway crest.
5. Remove and haul away debris and boulders from the tailrace area for the spillway immediately downstream of the dam.
6. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference. The emergency action plan described in section 7.1d should be maintained and updated periodically during the life of the structure.

## SECTION 4 - OPERATION AND MAINTENANCE PROCEDURES

### 4.1 PROCEDURES

The Garnerville reservoir discharges continuously through the 8-inch cast iron pipe and over the spillway throughout most of the year. Flow through the 8-inch pipeline goes directly to the manufacturing facility downstream and could be controlled through a valve at the downstream toe of the dam. Flow over the spillway is uncontrolled above spillway crest elevation 210. The 30-inch outlet is opened to lower the reservoir or check the operating mechanism.

### 4.2 MAINTENANCE OF DAM

There is no regular maintenance schedule for the dam. The dam is checked periodically by the maintenance staff of the owner and in particular the operating mechanisms are checked. Repair programs have been carried out, as required in the past, particularly in attempts to repair seepage in the masonry of the dam. The reservoir drain and pipeline are in good operating condition and appear to be maintained regularly. It is reported that due to vandalism the operation of the controls for the reservoir drains are checked regularly. The gate valves for the reservoir drain and pipeline are in good operating condition.

### 4.3 WARNING SYSTEM IN EFFECT

There are no warning systems in effect or in preparation.

### 4.4. EVALUATION

The overall maintenance of the Garnerville Dam is considered to be less than inadequate in the following area.

- (a) Control of vegetation and tree growth on upstream backfill.
- (b) Maintenance of the spillway crest and downstream tailrace area.
- (c) No formal operation and maintenance manuals exist in the project.

## SECTION 5 - HYDROLOGIC/HYDRAULIC

### 5.1 DRAINAGE BASIN CHARACTERISTICS

Garnerville Dam is located on Minisceongo Creek in West Haverstraw, Rockland County, New York. The watershed contributing to the reservoir is 17.5 square miles and is drained by Minisceongo Creek and its tributary, South Branch. Landcover varies from thickly wooded slopes through orchards, pastures, urban areas and several ponds and swamps. The longest watercourse is approximately 9.5 miles and falls over 1,000 feet to the normal lake elevation 210. The tributary, South Branch, flows northward and enters Minisceongo Creek about 2.4 miles upstream of the dam, falling from an elevation of 675 feet at its southern divide to about 370 feet at its confluence, a distance of approximately 5.7 miles.

### 5.2 ANALYSIS CRITERIA

The analysis of the Garnerville Dam was performed using the Corps of Engineers HEC-1 computer program<sup>1</sup>/. Because of the number of tributaries and the shape of the watershed contributing to the reservoir, it was necessary to divide the basin into three subareas. Snyder synthetic unit hydrographs were derived for each subarea and the reservoir inflow was simulated from this complex watershed. In accordance with the recommended guidelines of the Corps of Engineers<sup>7</sup>/, the adequacy of the spillway was analyzed using the Probable Maximum Flood (PMF) and one-half the PMF.

### 5.3 SPILLWAY CAPACITY

The principal spillway of Garnerville Dam is centrally located, 69 feet in length and 6.9 feet in depth. The crest is triangular in shape and is estimated to be at El 210. The computed maximum spillway discharge with the lake surface at El 216.9 is 3,890 cfs.

### 5.4 RESERVOIR CAPACITY

There was no data available on the normal capacity of Garnerville reservoir. However, for the purpose of this analysis, it has been estimated that normal capacity is 100 acre-feet, surcharge storage between spillway crest (El 210) and top of dam (El 216.9) is 98 acre-feet, which is equivalent to 0.1 inches of runoff over the entire basin. Maximum or total capacity of the reservoir is 198+ acre-feet.

### 5.5 FLOODS OF RECORD

There are no available records of the floods or maximum reservoir elevations. Maximum discharge at the Minisceongo Creek gage at Thiells (1959-1963) was 747 cfs on August 10, 1960.

## 5.6 OVERTOPPING POTENTIAL

The potential of the dam being overtopped was investigated on the basis of the spillway capacity and the available surcharge storage to meet the selected design flood inflows. The Probable Maximum Precipitation (PMP) for the Garnerville Dam area was obtained from Hydrometeorological Report No. 334/. The 24-hour index rainfall for each subarea was 21.9 inches. The initial rainfall loss for subareas A and B was estimated to be 2.0 inches in order to reflect the available surface storage, while subarea C with little basin storage had an initial loss of 1.0 inch. The constant loss for the entire basin was assumed to be 0.1 inches per hour. The combination of the hydrographs resulted in a peak inflow of 20,120 cfs. (1,000 CSM).

The PMF routed through the reservoir resulted in a peak outflow of 20,080 cfs and a corresponding water surface elevation of 222.87, 5.97 feet about the top of the dam. One-half the PMF overtops the dam by 2.84 feet with a peak discharge of 10,000 cfs. The spillway is capable of passing 19.4% of the PMF without overtopping the dam.

## 5.7 EVALUATION

The Garnerville Dam does not have sufficient spillway capacity to pass either the PMF or one-half the PMF. As a result of the spillways insufficient capacity and the condition as previously reported, which exists on the right abutment, the dam is assessed as seriously inadequate.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

#### a. Visual Observations

Visual observations did not indicate existing problems with the structure of the dams. The observed seepage on the downstream left wing of the dam is not considered to represent an unstable or otherwise dangerous condition. A potential stability problem does exist, however, because of the low point in the right abutment and the resulting higher potential for erosion.

#### b. Design and Construction Data

There exists no design computation or other data regarding the structural stability of the dam and the spillway. There are no documents or drawings showing the as-built section or details of the dam.

#### c. Stability Analysis

Since there are no contract drawings or documents available showing the full geometry or details of the dam, spillway, and foundation condition.

The primary source of structural and subsurface information used in stability analysis were: geometry observed and measures during the inspection visit and sketches supplied by the state from earlier inspections.

The following tables show the results of the structural stability analysis for spillway and non-overflow sections. The computations of analysis are given in Appendix E.

	<u>Non-Overflow Section</u>	<u>Overturning</u>	<u>Sliding Stability</u>
I)	Normal Loading Condition with Reservoir level at Spillway Crest; no ice load	Inside Middle third	1.92
II)	Normal Loading Condition with Reservoir level at Spillway Crest; with ice load	Inside Middle third	1.64
III)	Unusual Loading: One-half PMF, Water overtopping Dam by 2.84 feet	Inside Middle half	1.03
IV)	Extreme Loading: PMF, Water overtopping the Dam by 5.97 feet	Outside Middle half	0.95
V)	Unusual Loading: Reservoir level at Spillway Crest; 0.05 g earthquake force	Inside Middle half	1.51

	<u>Spillway</u>	<u>Overturning</u>	<u>Sliding Capacity</u>
I)	Normal Loading Condition with Reservoir level at Spillway Crest; no ice load	Inside Middle third	1.53
II)	Normal Loading Condition with Reservoir level at Spillway Crest; with ice load	Outside Middle third	1.3
III)	Unusual Loading: One-half PMF, Water overtopping Dam by 2.84 feet	Inside Middle half	0.90
IV)	Extreme Loading: PMF, Water overtopping the Dam by 5.97 feet	Outside Middle half	0.78
V)	Unusual Loading: Reservoir level at Spillway Crest; 0.05 g earthquake force	Inside Middle half	1.28

On the basis of Stability Analysis performed during the investigation, the structural stability of the non-overflow section of the dam against overturning was determined to be adequate for all cases except the Extreme Loading: PMF. The structural stability of the non-overflow section of the dam against the sliding was determined to be adequate for all cases except Unusual Loading: one-half PMF, and Extreme Loading: PMF.

On the basis of Structural Stability performed during the investigation, the structural stability of the overflow section of the dam against overturning was determined to be adequate for all cases except Normal Loading condition with ice load and Extreme Loading: PMF. The stability of the overflow section of the dam against sliding was determined to be adequate for all cases except Normal Loading condition with ice load, Unusual Loading: one-half PMF, and Extreme Loading: PMF.

Since exact geometry, foundation conditions, upstream backfill characteristics and extent, as well as the extent and magnitude of the uplift pressure are unknown, it is therefore, recommended that with the spillway adequacy studies a more detailed structural stability analysis be performed. Field investigations, should be done to obtain more information regarding the extent and characteristics of the backfill and foundation materials; as well as the quality and condition of the non-exposed masonry of the structure. Based on the results of the analysis, modification of the dam should be recommended as required.

#### d. Operation Records

There are no records of the regulating gates operations. No major operational problems, which would affect the stability of the dam were reported.

e. Post Construction Changes

Several post construction changes have been carried out on or near the dam which would have an affect on the stability of the dam. The flashboard structure has been constructed across the spillway to raise the reservoir level and, therefore, increase the normal hydrostatic load, but this structure was destroyed during a flood and never rebuilt. A second post construction change which still poses a potential stability problem is the addition of runoff drain to the reservoir near the right abutment. Observations indicate that a low point which exists on the abutment is probably a result of this construction. This creates an area of greater erosion potential.

f. Seismic Stability

The dam is located in Zone 2, therefore, a stability analysis was carried out using a normal reservoir loading (water level at spillway crest) and a 0.05g earthquake factor with Zangers method. The results of this analysis showed the dam to be safe under both overturning and sliding.

## SECTION 7 - ASSESSMENT/RECOMMENDATIONS

### 7.1 ASSESSMENT

#### a. Safety

Examination of the available documents and visual inspections of the Garnerville Dam and appurtenant structures did not reveal conditions which constitute a hazard to human life or property.

Using the Corps of Engineers Screening Criteria for review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 19.4 percent of the PMF. The overtopping of the dam could cause erosion of the right abutment and near the toe of the dam. This could result in possible instability due to undermining leading to dam failure and thus increasing the hazard to loss of life downstream. The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate" spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency in spillway computations, that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

On the basis of Stability Analysis performed during the investigation, the structural stability of the non-overflow section of the dam against overturning was determined to be adequate for all cases except the Extreme Loading: PMF. The structural stability of the non-overflow section of the dam against sliding was determined to be adequate for all cases except Unusual Loading: one-half PMF, and Extreme Loading: PMF.

On the basis of Structural Stability performed during the investigation, the structural stability of the overflow section of the dam against overturning was determined to be adequate for all cases except Normal Loading condition with ice load and Extreme Loading: PMF. The stability of the overflow section of the dam against sliding was determined to be adequate for all cases except Normal Loading condition with ice load, Unusual Loading: one-half PMF, and Extreme Loading: PMF.

A more detailed structural stability analysis is required. Field investigations are required to obtain more information regarding the extent and magnitude of uplift pressures under the base of the dam and spillway, quality of the masonry and concrete and the extent and characteristics of the backfill and foundation materials. This information should then be incorporated into a detailed structural stability evaluation.

b. Adequacy of Information

The information and data available were adequate for performance of this investigation.

c. Need for Additional Investigations

Since the spillway is considered to be "seriously inadequate", additional hydrologic/hydraulic investigations are required to more accurately determine the site specific characteristics of the watershed. After the in-depth hydrologic/hydraulic investigations have been completed, remedial measures must be initiated to provide spillway capacity sufficient to discharge the outflow from the 1/2 PMF event. In addition, an investigation of the structural stability of the spillway and non-overflow portions of the dam are required.

d. Urgency

The additional hydrologic/hydraulic investigations and the stability investigation which are required must be initiated within 3 months from the date of notification. Within 1 year of notification, remedial measures as a result of these investigations must be initiated, with completion of these measures during the following year. In the interim, develop an emergency action plan for the notification of downstream residents and proper governmental authorities in the event of overtopping and provide round-the-clock surveillance of the dam during periods of extreme run-off. The other problem areas listed below must be corrected within 1 year from notification.

7.2 RECOMMENDED MEASURES

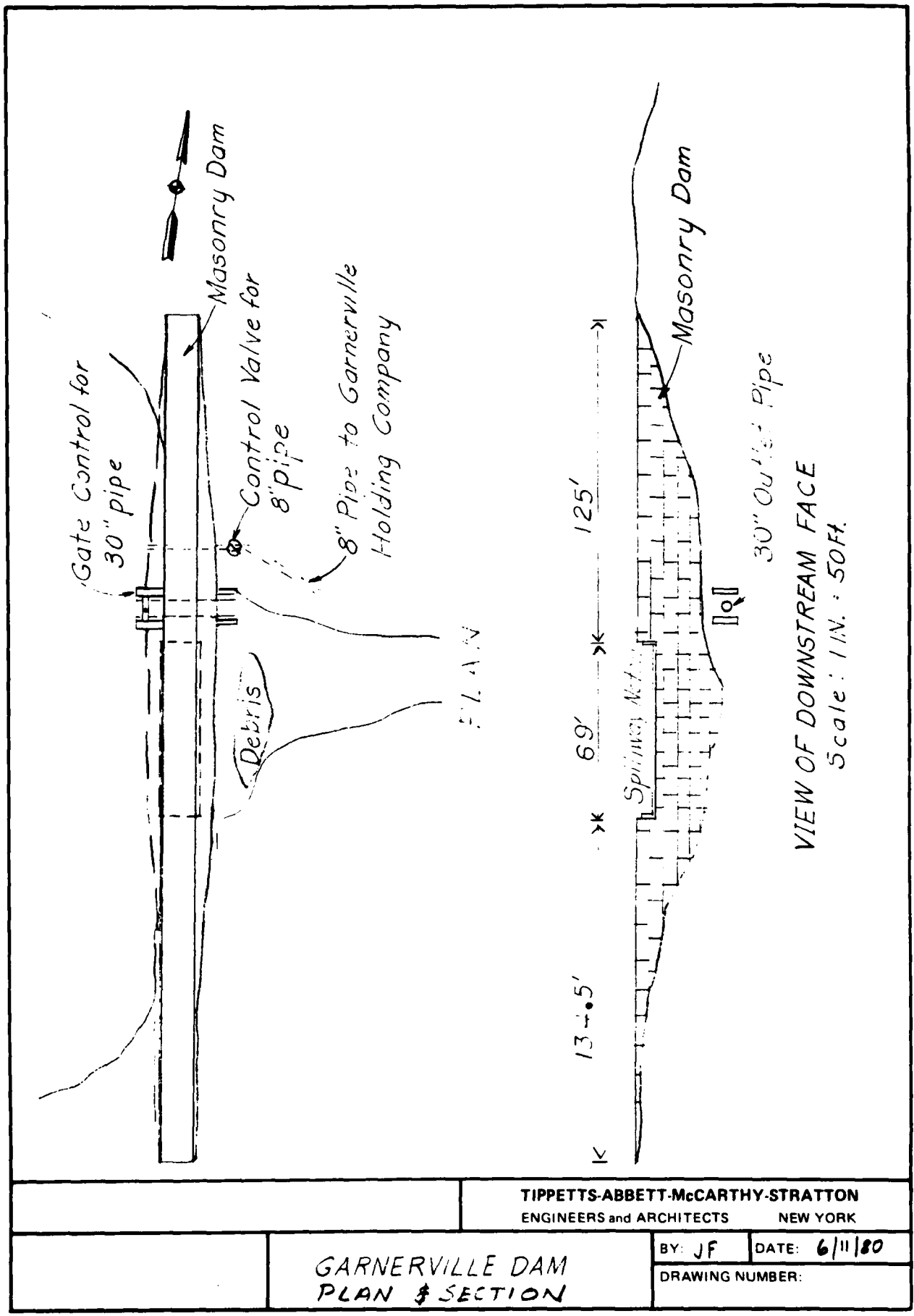
The following are the recommended measures.

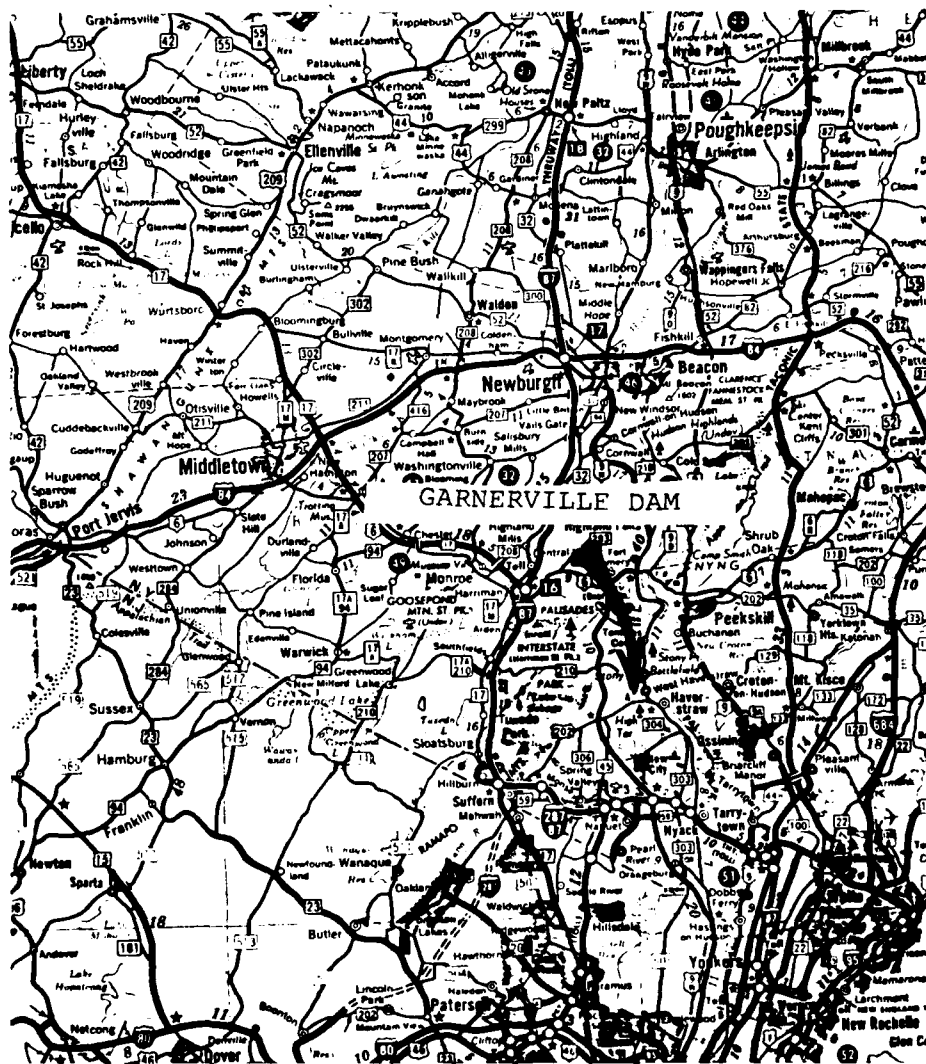
1. Backfill the low saddle in the right abutment to an elevation equal to that of the top of the dam.
2. Monitor the seepages at the downstream of the right abutment and through the masonry on the downstream face of the dam at bi-weekly intervals with aid of weirs. In addition, determine the source of the seepage in the right abutment.
3. Remove all trees on the backfill at the upstream face of the dam. Provide a program of periodic cutting and brushing of the backfill.
4. Remove and haul away debris from the spillway crest.
5. Remove and haul away debris and boulders from the tailrace area for the spillway immediately downstream of the dam.

6. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference. The emergency action plan described in section 7.1d should be maintained and updated periodically during the life of the structure.

DRAWINGS

APPENDIX A





SCALE: 1 inch = 11.2 Miles

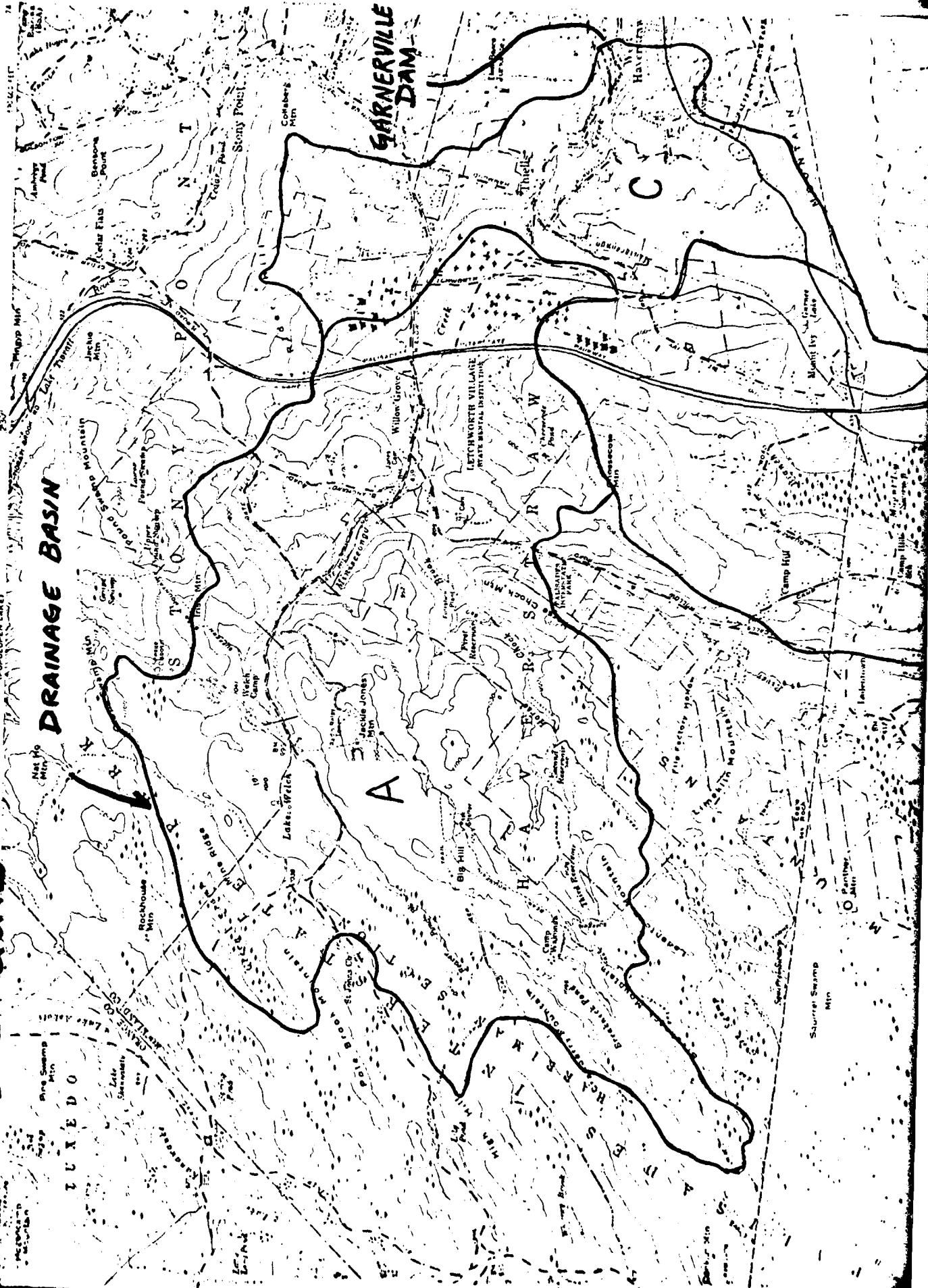
VICINITY MAP

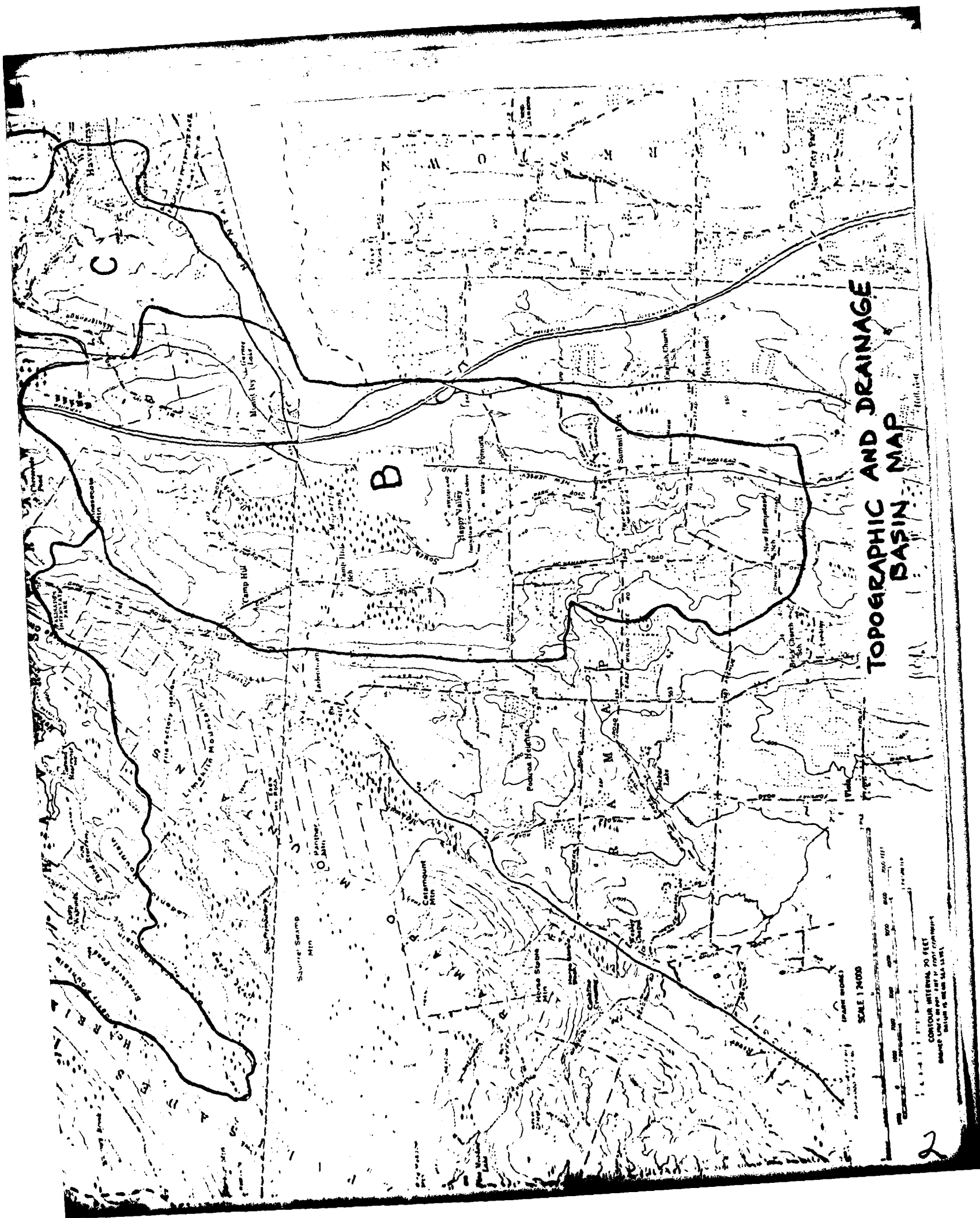
SECTION OF THE HILLOCK

# THIELLS QUAD

75 MINUTE BLANKS (1:50,000) MAP  
Revised 1964

## DRAINAGE BASIN





PHOTOGRAPHS

APPENDIX B



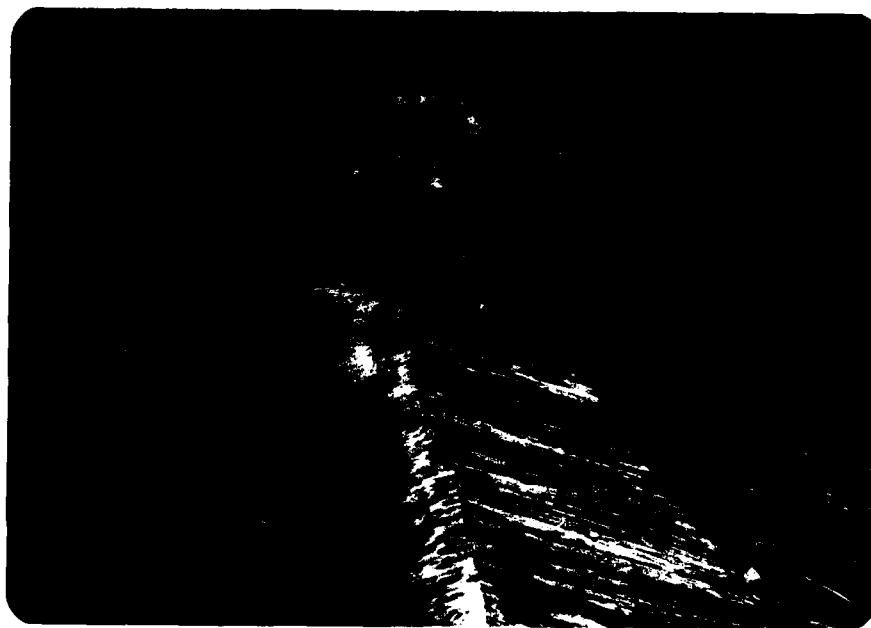
2. VIEW OF UPSTREAM FACE OF DAM.



3. VIEW OF DOWNSTREAM CHANNEL.



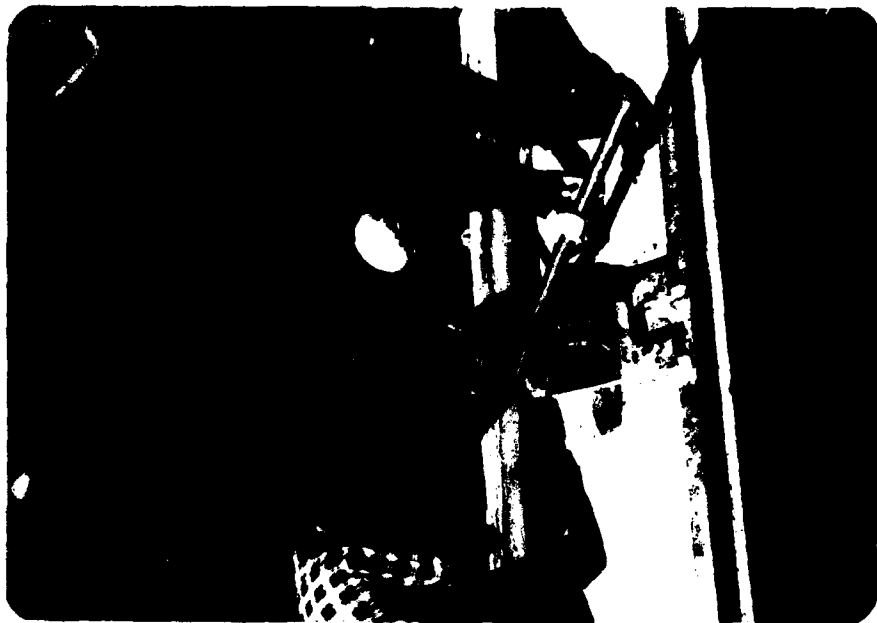
4. VIEW OF SPILLWAY AND CREST OF RIGHT NON-OVER FLOW SECTION OF DAM. NOTE: CONDITION OF BOARDS, VEGETATION ON UPSTREAM FACE.



5. VIEW LOOKING TOWARDS LEFT NON-OVER FLOW SECTION OF DAM. NOTE: UPSTREAM VEGETATION, CONTROL FOR RESERVOIR DRAIN, DETERIORATION OF CONCRETE DUE TO FROST ACTION.



6. VIEW OF DOWNSTREAM OF RESERVOIR  
DRAIN.



7. VIEW OF OPERATING MECHANISM  
FOR RESERVOIR DRAIN



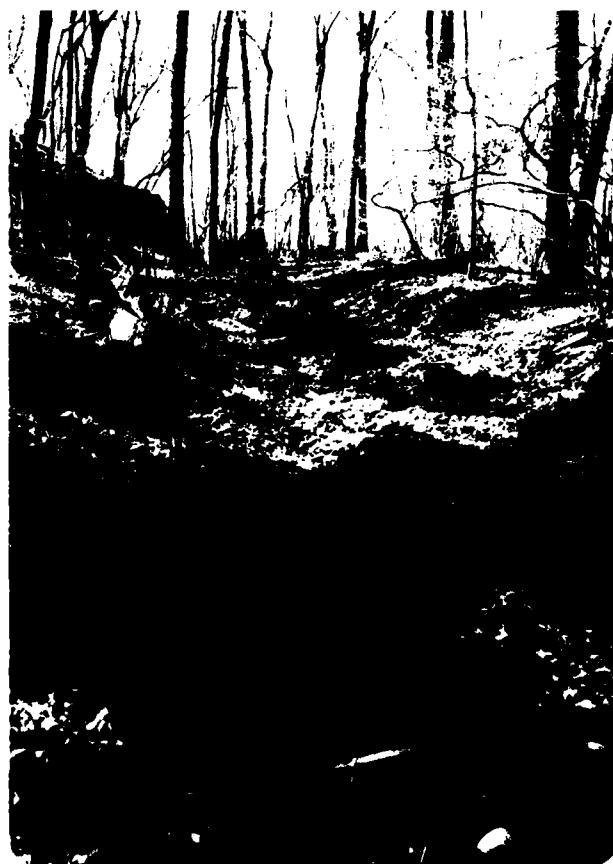
8. VIEW OF CONTROL VALVE FOR 8-INCH WATER SUPPLY PIPE.



9. VIEW OF SEEPAGE ON DOWNSTREAM FACE OF LEFT NON-OVERFLOW SECTION OF DAM.



10. VIEW OF DEPRESSION IN RIGHT ABUTMENT IMMEDIATELY  
ADJACENT TO DAM (LOOKING UPSTREAM) .



11. VIEW OF SEEPAGE DOWNSTREAM OF  
RIGHT ABUTMENT DEPRESSION.

VISUAL INSPECTION CHECKLIST

APPENDIX C

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam GARNERVILLE DAM  
Fed. I.D. # NY 744 DEC Dam No. 196B-337B  
River Basin Lower Hudson  
Location: Town Garnerville County Rockland  
Stream Name Minisceongo Creek  
Tributary of Hudson River  
Latitude (N) 41° 12' Longitude (W) 74° 00'  
Type of Dam Masonry - Gravity  
Hazard Category High  
Date(s) of Inspection April 24, 1980  
Weather Conditions Fair 60°-65° F  
Reservoir Level at Time of Inspection El. 210. (During inspection lowered 1 to 2 feet.)

b. Inspection Personnel Kalman Szalay - Principal Geotechnical Engr  
Joseph Fiteni, Jr. - Geotechnical Engr

c. Persons Contacted (Including Address & Phone No.) MR William Daker  
GARNERVILLE HOLDING COMPANY, 55 Railroad Ave, GARNERVILLE  
NY 10942 (914) 947-1155. MR DAVID LIPMAN  
Same as above

d. History:

Date Constructed 1875 Date(s) Reconstructed \_\_\_\_\_  
Designer Not Known  
Constructed By Not Known  
Owner GARNERVILLE Holding Company

2) Embankment

NONE

a. Characteristics

- (1) Embankment Material NA
- (2) Cutoff Type NA
- (3) Impervious Core NA
- (4) Internal Drainage System NA
- (5) Miscellaneous NA

b. Crest

- (1) Vertical Alignment NA
- (2) Horizontal Alignment NA
- (3) Surface Cracks NA
- (4) Miscellaneous NA

c. Upstream Slope

- (1) Slope (Estimate) (V:H) \_\_\_\_\_
- (2) Undesirable Growth or Debris, Animal Burrows \_\_\_\_\_
- (3) Sloughing, Subsidence or Depressions \_\_\_\_\_

(4) Slope Protection \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(5) Surface Cracks or Movement at Toe \_\_\_\_\_

\_\_\_\_\_

d. Downstream Slope

(1) Slope (Estimate - V:H) \_\_\_\_\_

(2) Undesirable Growth or Debris, Animal Burrows \_\_\_\_\_

\_\_\_\_\_

(3) Sloughing, Subsidence or Depressions \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(4) Surface Cracks or Movement at Toe \_\_\_\_\_

\_\_\_\_\_

(5) Seepage \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(6) External Drainage System (Ditches, Trenches; Blanket) \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(7) Condition Around Outlet Structure \_\_\_\_\_

\_\_\_\_\_

(8) Seepage Beyond Toe \_\_\_\_\_

\_\_\_\_\_

e. Abutments - Embankment Contact

\_\_\_\_\_

\_\_\_\_\_

(1) Erosion at Contact \_\_\_\_\_  
\_\_\_\_\_

(2) Seepage Along Contact \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3) Drainage System

a. Description of System None in existence  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b. Condition of System \_\_\_\_\_  
\_\_\_\_\_

c. Discharge from Drainage System \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) None

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5) Reservoir

- a. Slopes Generally Stable - Some retaining walls in place
- b. Sedimentation NO EVIDENCE OF EXCESSIVE SEDIMENTATION OBSERVED; NO FLOATING DEBRIS
- c. Unusual Conditions Which Affect Dam None

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) Several Highway Bridge - , Dense Building - Homes AND Businesses
- b. Seepage, Unusual Growth Through Face of Dam and also ~300 feet D/s on left abutment
- c. Evidence of Movement Beyond Toe of Dam None
- d. Condition of Downstream Channel Some blockage by Trees and remains of old Railroad bridges

7) Spillway(s) (Including Discharge Conveyance Channel)

- Over flow section in center portion of Dam
- a. General Attempts have been made at various times to modify or repair the spillway. The result is that the original spillway has been covered by concrete and wood - both of which have now deteriorated
- b. Condition of Service Spillway Difficult to judge due to remnants of previous repairs.

c. Condition of Auxiliary Spillway None

d. Condition of Discharge Conveyance Channel None

8) Reservoir Drain/Outlet

Type: Pipe 30" and 8" Conduit \_\_\_\_\_ Other \_\_\_\_\_

Material: Concrete \_\_\_\_\_ Metal Cast Iron Other \_\_\_\_\_

Size: 30" and 8" Length 30"  $\approx$  25', 8"  $\approx$  1 mile

Invert Elevations: Entrance \_\_\_\_\_ Exit \_\_\_\_\_

Physical Condition (Describe): \_\_\_\_\_ Unobservable ✓

Material: \_\_\_\_\_

Joints: \_\_\_\_\_ Alignment \_\_\_\_\_

Structural Integrity: Appears to be intact

Hydraulic Capability: \_\_\_\_\_

Means of Control: Gate \_\_\_\_\_ Valve ✓ Uncontrolled \_\_\_\_\_

Operation: Operable ✓ Inoperable \_\_\_\_\_ Other \_\_\_\_\_

Present Condition (Describe): Good working order

9) Structural

- a. Concrete Surfaces generally good. Some Spalling  
near line of ice contact.
- b. Structural Cracking None evident
- c. Movement - Horizontal & Vertical Alignment (Settlement) None  
evident
- d. Junctions with Abutments or Embankments left Abutment  
good - low saddle in Rt abutment near  
contact.
- e. Drains - Foundation, Joint, Face None existent
- f. Water Passages, Conduits, Sluices appear to be good.
- g. Seepage or Leakage Small seepage from several  
"cracks" in masonry on left non-overflow  
section. Flow ranges from 1 to 3 gpm.  
No fines in flow

- h. Joints - Construction, etc. Masonry joints are  
generally in good condition. Some pointing has  
been done in recent years
- i. Foundation Hardpan - generally sound
- j. Abutments lt abutment has low saddle
- k. Control Gates operable
- l. Approach & Outlet Channels Approach not visible, reported  
to be good. Outlet - good condition
- m. Energy Dissipators (Plunge Pool, etc.) None
- n. Intake Structures Appears to be good - upstream  
screen structure somewhat dilapidated
- o. Stability Appears stable
- p. Miscellaneous

HYDROLOGIC DATA AND COMPUTATION

APPENDIX D

# TAMS

Job No. 1551-10  
Project GARNERVILLE DAM PHASE 1 INSPECTION  
Subject HYDROLOGIC/HYDRAULIC COMPUTATIONS  
SUB AREA A

Sheet 1 of 6  
Date MAY 15 1980  
By D.L.C.  
Ch'k. by \_\_\_\_\_

$$\begin{aligned}T_p &= C_T (L L_a)^{0.3} \\&= 2.525 [(7.1)(3.2)]^{0.3} \\&= (2.525)(2.55) \\&= 6.44\end{aligned}$$

$$\begin{aligned}L &= 7.1 \text{ mi} \\L &= 3.2 \text{ mi} \\C_T &= 2.525 \\C_p &= 0.625 \\A &= 8.2 \text{ sq mi}\end{aligned}$$

use  $t_r = 1$  hour

$$\begin{aligned}q_p &= \frac{640 C_p}{T_p} \\&= \frac{400}{6.44} \\&= 62.1 \text{ cfs/sq mile}\end{aligned}$$

$$Q_p = 509.2 \text{ cfs.}$$

Initial loss 2"

Constant loss 0.1 inch/hour

# TAMS

Job No. 1551-10

Project GARNEVILLE DAM PHASE 1 INSPECTION

Subject HYDROLOGIC / HYDRAULIC COMPUTATIONS

SUB BASIN B

Sheet 2 of 6

Date MAY 16 1960

By D. L. C

Ch'k. by \_\_\_\_\_

$$\begin{aligned}
 T_p &= C_T (L L_{CA})^{0.3} \\
 &= 2.67 [(5.7)(2.6)]^{0.3} \\
 &= 2.67 \times 2.245 \\
 &= 6.0 \text{ hours}
 \end{aligned}$$

$$\begin{aligned}
 L &= 5.7 \text{ mi} \\
 L_{CA} &= 2.6 \text{ mi} \\
 C_T &= 2.67 \\
 C_p &= 0.625 \\
 A &= 6.9 \text{ mi}^2
 \end{aligned}$$

Use  $T_n = 1.0 \text{ hour}$

$$\begin{aligned}
 Q_{DP} &= \frac{640 C_p}{T_p} \cdot \frac{640 \times 0.625}{6.00} \\
 &= 66.7
 \end{aligned}$$

$$\begin{aligned}
 Q_p &= 66.7 \times 6.9 \\
 &= 460 \text{ cfs.}
 \end{aligned}$$

Initial loss 2.0"

Constant loss 0.1 in/hour.

# TAMS

Job No. 1551-10

Project GARNERVILLE DAM

Subject HYDROLOGIC / HYDRAULIC COMPUTATIONS

SUB AREA C

Sheet 3 of 6

Date MAY 16 1960

By D.L.C.

Ch'k. by

$$T_p = C_T (L L_{CA})^{0.3}$$

$$= 2 [(2.4)(1.3)]^{0.3} = 2 \times 1.407$$

$$= 2.8 \text{ hrs}$$

$$L = 2.4 \text{ Mi.}$$

$$L_{CA} = 1.3 \text{ Mi.}$$

$$A = 2.4 \text{ SQ MI.}$$

$$T_h = 2.8 / T_p = 0.5 \text{ hours.}$$

$$\text{USE } t_R = 1.0$$

$$T_{PR} = t_p + 0.25(T_R - t_h)$$

$$= 2.8 + .25(.5)$$

$$= 2.925 \text{ hrs}$$

$$q_p = \frac{640 C_p}{T_p} = \frac{400}{2.8}$$

$$= 142.9 \text{ cfs/sq mile}$$

$$Q_p = 142.9 \times 2.4$$

$$= 342.8 \text{ cfs.}$$

$$q_{PR} = 136.7 \text{ cfs/sq m.}$$

$$C_{PR} = 328 \text{ cfs}$$

Cross-section for routing combined hydrographs from  
Sub Areas A & B through Sub Area C

36+00		54+00		76+00		96+00		114+00	
STATION	ELEVATION	STATION	ELEVATION	STN	EL	STN	EL	STN	EL
7450	580			6800	320				
8150	560	6710	360	7460	350	5350	300	7290	250
8220	340	6750	300	7600	290	5520	270	7380	260
8250	325	6810	320	7710	260	5600	260	7460	260
8500	328	6820	315	8000	270	5800	240	7510	220
8540	340	7060	300	8020	280	6000	228	7540	210
8600	340	7000	310	8150	300	6100	210	7550	220
8600	340	7000	310	8200	320	6100	200	7550	230
8600	380	7000	300			6150	270	7550	220
		7410	300			6150	271	7550	220
						6200	220	7550	220
						6450	300	7550	220

# TAMS

Job No. 1551-10

Project GARNERVILLE DAM PHASE 1 INSPECTION

Subject HYDROLOGIC / HYDRAULIC COMPUTATION

SPILLWAY RATING  $C \approx 3.46$

Sheet 4 of 6

Date MAY 28 1990

By DLC

Ch'k. by \_\_\_\_\_

Assume Coef C reduced 10% due to poor condition of spillway surface

Use  $C' = 3.114$

$$Q = C' L H^{3/2}$$

Flow over DAM

$L = 260$   $C' = 2.778$

$L = 690'$

$E_L$	$H$	$L \times C'$	$Q$	
210	0	214.87	0	
211	1		215	
212	2		608	
214	4		1720	
216	6		3160.	
216.9	6.9		3890.	TOP OF DAM
218	8		4860.	830.
220	10		6790.	3940 10730

P1 @ 24 HR 200 V.S. (15000)

24.5%

% Point 2M

CHIC 122.1

122.4

24 HR 134.7

45 HOUR 151.0

7... 157.1

# TAMS

Job No. 1551-10

Project GARDINERVILLE DAM PHASE 1 INSPECTION

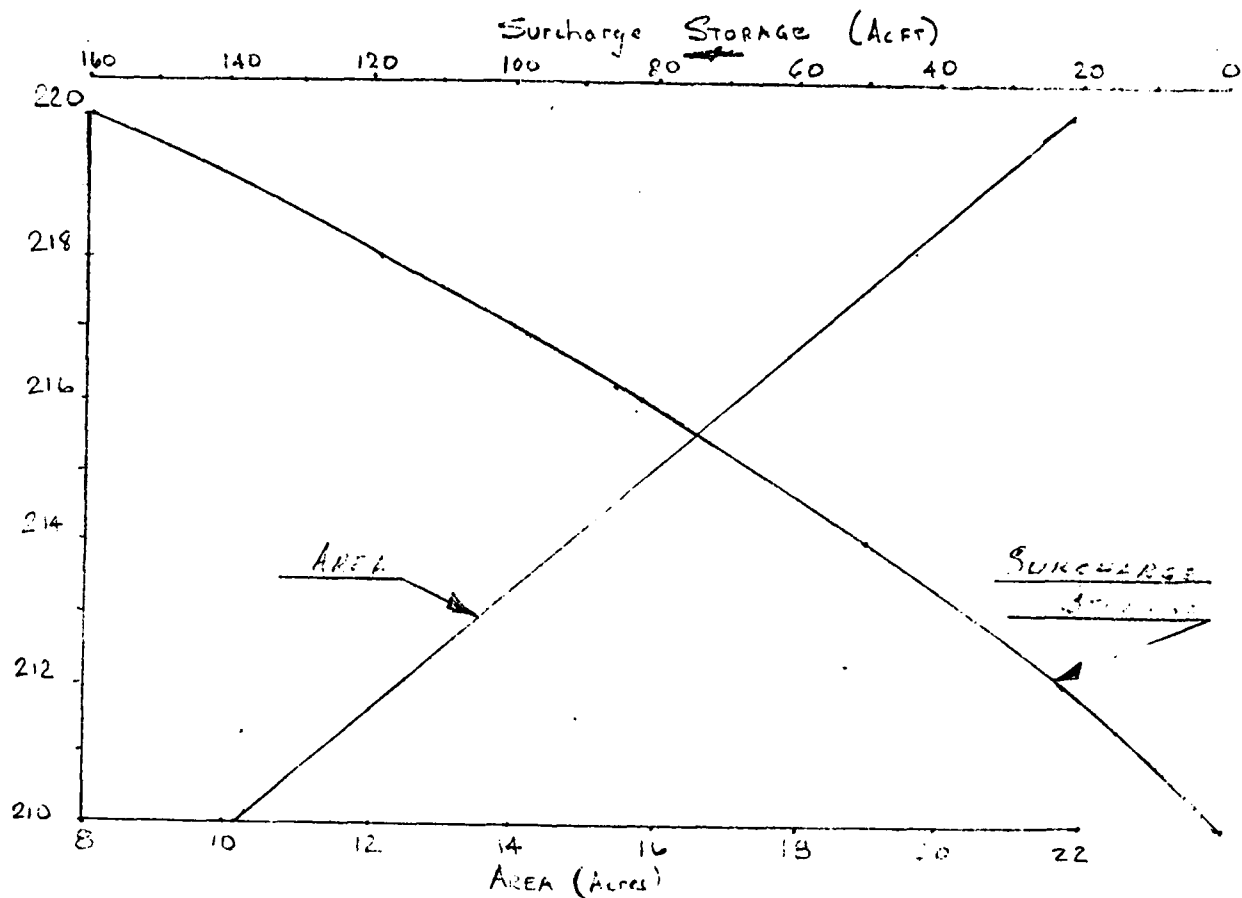
Subject EL/AREA/ SURCHARGE STORAGE.

Sheet 5 of 6

Date MAY 30 19

By DLC

Ch'k. by \_\_\_\_\_



EL	ZH	AREA	MEAN AREA	Σ VOL.	SURCHARGE STORAGE
	(Ft)	(Ac)	(Ac)	(Acft)	(Acft)
210		10.2			0
	2		11.35	22.7	
212		12.5			22.7
	2		13.65	27.3	
214		14.8			50
	2		16.	33.0	
216		17.2			82
	2		18.35	36.7	
218		19.5			118.7
	2		20.65	41.3	
220		21.8			160.

Assume Vol of Dam at EL 210 (Normal Pond) = 100 Acft.

# TAMS

Job No. 1551-10

Project GIARNEVILLE DAM PHASE I INSPECTION

Subject HYDROLOGIC/HYDRAULIC COMPUTATIONS

Sheet 6 of 6

Date JUNE 4 1990

By DLC

Ch'k. by \_\_\_\_\_

CROSS SECTIONS - from USGS QUADRANGLE MAP below DAM

STN 2+00

STATION	ELEV
1500	220
1590	200
1690	195
1730	194
1960	180
2000	175
2040	180
2140	200
2200	220

STN 22+00

STN	ELEVATION
6900	170
7300	160
7860	152
7900	151
7930	150
8000	140
8040	150
8180	160
8200	170

STN 24+00

6920	150
6940	140
6970	130
6980	120
7000	115
7030	120
7070	130
7100	140
7750	150

[illegible]



FW	C	QUEN	STR	JETW	ALCU	NS
				A		
				B		
				A P		
				1P+00		
				76+00		
				114+0		
				C		
				COMBINE 2 HYDROGRAPHS AT INFLOW		
				ROUTE HYDROGRAPH TO	100	
				ROUTE HYDROGRAPH TO	2+00	
				ROUTE HYDROGRAPH TO	39+00	
				END OF NETWORK		

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1979  
 LAST MODIFICATION 25 FEB 79  
 \*\*\*\*\*

FILE DATE 07/7/23  
 TIME 10:22:07

PHASE 1 INSPECTION GARNERVILLE DAM ROCKLAND COUNTY N.Y. 1551-10  
 TAMS ENGINEERS AND ARCHITECTS  
 MAY 1980

JOB SPECIFICATION									
NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	1	0	0	0	0	0	0	0	0
	JOPEP	5		NWT	LROPT	TRACE			
				0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED  
 NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

\*\*\*\*\*  
 SUP-AREA RUNOFF COMPUTATION  
 \*\*\*\*\*

SUP-AREA RUNOFF

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A	0	0	0	1	0	1	0	0

HYDROGRAPH DATA

INVDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	8.20	0.00	8.20	0.00	0.000	0	1	0

PRECIP DATA  
 SPEE PMS R4 R12 R24 R4P R72 R96  
 6.00 21.00 110.50 122.00 132.00 142.00 0.00 0.00

TESTS COMPLETED BY THE PROGRAM IS 0.00

LOSS DATA

LEOPT	STKR	PLINE	RTIOL	ERAIN	STKRS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	2.00	0.00	.10	0.00	.05

UNIT HYDROGRAPH DATA  
 TP= 6.44 CP= .63 NTA= 0

PRECSSION DATA

STRTQ= -1.00 ORCSH= -1.50 RTIOR= 3.00  
 APPROXIMATE CLAW COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 7.50 AND R= 5.92 INTERVALS

UNIT HYDROGRAPH OF END-OF-PERIOD COORDINATES- LAG= 6.50 HOURS, CP= .63 VOL= 1.00

20.	134.	27.	321.	423.	401.	516.	488.	422.	356.
21.	274.	146.	181.	153.	129.	100.	92.	78.	66.
22.	47.	27.	23.	23.	24.	20.	17.	14.	12.
23.	9.	7.	4.	5.	4.				

END-OF-PERIOD DATA



HYDROGRAPH AT STAA		FOR PLAN 1, RYIO 2				TOTAL	VOLUME
3.	3.	3.	2.	2.	2.		
7.	3.	4.	6.	8.	11.	2.	2.
15.	16.	14.	13.	12.	17.	14.	17.
39.	108.	156.	213.	205.	430.	13.	16.
342.	4100.	4514.	4611.	4186.	3937.	681.	1112.
1540.	1750.	1410.	1263.	1263.	1132.	3420.	2925.
583.	585.	524.	470.	421.	377.	1014.	908.
243.	195.	175.	157.	140.	126.	338.	303.
73.	65.	58.	52.	42.	47.	113.	101.
24.	22.	19.	17.	16.	14.	38.	34.
27.						13.	11.

SUP-AREA RUNOFF COMPUTATION

SSUP PASIN F RUNOFF

HYDROGRAPH DATA									
ISTAQ	ICOMP	ICON	ITAPE	JPLT	JPRF	INAME	ISTAGE	IAUTO	
8	0	0	0	0	0	0	0	0	
HYDROGRAPH DATA									
IUNG	TAREA	SWAP	TRSDA	TESPC	RATIO	ISNOW	ISAME	LOCAL	
1	6.50	0.50	6.00	0.00	0.000	0	1	0	

PRECIP DATA

5445 1445 94

RESEC COMPUTED BY THE PROGRAM IS 0.00 21.

[illegible]





COMP UNOT ICOMP IECN ITAPE JPLT INAME ISTAGE IAUTO  
A R 2 0 0 1 0 0

SUP OF 2 HYDROGRAPHS AT A B PLAN 1 RTIO 1  
12. 11. 10. 9. 8.  
5. 9. 11. 14. 36.  
57. 54. 48. 42. 37.  
52. 54. 48. 42. 37.  
146. 254. 414. 613. 1152.  
10276. 13489. 16016. 17365. 17400. 14316. 1721. 2888. 4421.  
8037. 1107. 6367. 5705. 5111. 4579. 4103. 12286. 10420.  
2631. 2444. 2122. 1902. 1704. 1526. 1368. 3676. 3294.  
934. 790. 707. 634. 581. 509. 456. 1088. 1225.  
322. 284. 211. 189. 170. 152. 136. 366. 322.  
106. 88. 79. 67. 57. 51. 45. 122. 122.  
106. 88. 79. 67. 57. 51. 45. 122. 122.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME  
CFS 17400. 8509. 3224. 232792.  
CMS 493. 241. 91. 6592.  
INCHES 9.67 20.97 23.83 23.90  
WM 245.46 522.61 605.35 607.11  
AC-FT 7785. 16878. 19187. 19239.  
THOUS CU M 9603. 20619. 23662. 23731.

SUM OF 2 HYDROGRAPHS AT A P PLAN 1 RTIO 2  
7. 6. 5. 5. 4. 4.  
4. 5. 5. 7. 9. 18.  
25. 27. 24. 21. 19. 18.  
41. 126. 207. 306. 417. 576. 861. 1344. 2211.  
3536. 6745. 8008. 8482. 8700. 8107. 7158. 6143. 5210.  
3968. 3553. 3184. 2852. 2536. 2290. 2051. 1838. 1647.  
1275. 1184. 1161. 851. 837. 763. 684. 540. 183.  
441. 395. 354. 317. 284. 254. 228. 204. 183.  
147. 132. 118. 106. 95. 85. 76. 68. 61.  
49. 44. 39. 35. 32. 28. 25. 23. 20.  
PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME  
CFS 8700. 7850. 4255. 1612. 116396.  
CMS 246. 222. 120. 46. 3296.  
INCHES 4.84 10.48 11.92 11.05  
WM 122.87 266.31 302.68 303.55  
AC-FT 3692. 8439. 9592. 9620.  
THOUS CU M 4601. 10410. 11831. 11865.

\*\*\*\*\*

# HYDROGRAPH ROUTING

## WINICEONGO CREEK CHANNEL ROUTING

ISTAG ICOMP IECN ITAPE JPLT INAME ISTAGE IAUTO  
1E+00 1 0 0 0 0 0  
GLOSS CROSS AVG IRFS ISAME IOPT IPMP LSTR  
0.0 0.00 0.00 1 1 0 0  
ASTPS NSTDL LAG AMSKK X TSK STORA ISPRAT  
1 0 0 0.000 0.000 0.000 0.000 0.000 0.000

FLVLT	FLMAX	RLNTH	SFL
222.3	389.0	3600.	.00500

COORDS	SECTION	COORDINATES	--STA	ELEV	STA	FLEV	--ETC
730.0	0	320.00	423.00	320.00	4220.00	340.00	
732.0	0	320.70	445.00	320.00	4630.00	380.00	

[illegible]

STATION 10+00, PLAN 1, RTIO 1

OUTFLOW									
17.	12.	12.	10.	9.	9.	8.	8.		
6.	9.	17.	12.	17.	24.	33.	43.		51.
56.	55.	44.	39.	36.	36.	41.	41.		51.
72.	126.	564.	801.	1087.	1607.	1607.	2695.		6175.
42.	1570.	1580.	17336.	17416.	16361.	18463.	12450.		10549.
130.	7185.	6453.	5772.	5777.	4635.	4155.	3721.		3335.
130.	2704.	2410.	1737.	1737.	1556.	1394.	1249.		1119.
130.	893.	721.	646.	579.	519.	466.	424.		378.
129.	244.	219.	196.	176.	157.	141.	126.		126.
113.	91.	73.	65.	50.	52.	47.	42.		42.
STOR									
5.	0.	0.	0.	0.	0.	0.	0.		0.
5.	0.	0.	0.	1.	1.	1.	1.		1.
1.	1.	1.	1.	1.	21.	28.	41.		59.
2.	3.	13.	158.	159.	152.	140.	127.		115.
33.	132.	148.	74.	68.	63.	59.	55.		51.
105.	95.	80.	33.	30.	28.	25.	23.		21.
20.	44.	36.	13.	14.	13.	12.	11.		10.
20.	17.	16.	6.	5.	4.	3.	3.		3.
3.	2.	2.	2.	2.	1.	1.	1.		1.

## STAGE

SIPROE	
328.1	328.1
328.1	328.1
328.3	328.3
328.3	328.3
328.4	328.4
328.4	328.4
328.5	328.5
328.5	328.5
328.6	328.6
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328.7	328.7
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328.9	328.9
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329.0	329.0
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330.3	330.3
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330.6	330.6
330.6	330.6
330.7	330.7
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330.8	330.8
330.9	330.9
330.9	330.9
331.0	331.0
331.0	331.0
331.1	331.1
331.1	331.1
331.2	331.2
331.2	331.2
331.3	331.3
331.3	331.3
331.4	331.4
331.4	331.4
331.5	331.5
331.5	331.5
331.6	331.6
331.6	331.6
331.7	331.7
331.7	331.7
331.8	331.8
331.8	331.8
331.9	331.9
331.9	331.9
332.0	332.0
332.0	332.0
332.1	332.1
332.1	332.1
332.2	332.2
332.2	332.2
332.3	332.3
332.3	332.3
332.4	332.4
332.4	332.4
332.5	332.5
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332.6	332.6
332.6	332.6
332.7	332.7
332.7	332.7
332.8	332.8
332.8	332.8
332.9	332.9
332.9	332.9
333.0	333.0
333.0	333.0
333.1	333.1
333.1	333.1
333.2	333.2
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333.7	333.7
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334.0	334.0
334.0	334.0
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**THE UNIVERSITY OF CHICAGO**



100 0.00 0.00 0.00 18.  
SUM 24.88 20.82 4.06 107891.

WAVING STAGE IS 334.0

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# HYDROGRAPH ROUTING

## CHANNEL ROUTING MINISCONGO CREEK

ISTAR ICOMP IFCON ITAPE JPLT JPRT INAME ISTAGE IAUTO  
76+00 1 0 0 0 0 0 0  
ROUTING DATA  
GROSS CLOSS AVG IRES ISAME IOPT IPWP LSTR  
0.0 0.000 0.00 1 1 0 0 0  
ASTPS NSTDL LAG AMSKV X TSK STORA ISPRAT  
1 0 0 0.000 0.000 0.000 0 0

## NORMAL DEPTH CHANNEL ROUTING

CROSS SECTION COORDINATES--STA/ELEV/STA/ELEV--ETC  
4511.00 320.00 7640.00 350.00 7640.00 290.00 7710.00 280.00 8000.00 270.00  
5727.42 250.00 8150.00 300.00 8300.00 320.00

STATION	0.00	9.86	20.47	88.71	157.49	238.41	327.91	426.01	533.24	654.80
OUTFLOW	761.97	944.65	1114.78	1309.85	1530.67	1777.25	2049.59	2347.68	2671.52	3021.12
STAGE	270.00	272.63	275.26	277.89	280.53	283.16	285.79	288.42	291.05	293.68
FLCA	321412.39	321412.99	321413.41	321413.85	321414.29	321414.73	321415.17	321415.61	321416.05	321416.49

STATION 76+00, PLAN 1, RTIO 1

STATION	76+00	76+10	76+20	76+30	76+40	76+50	76+60	76+70	76+80	76+90	77+00
OUTFLOW	24.	11.	12.	9.	10.	9.	8.	8.	8.	8.	8.
STAGE	270.00	272.63	275.26	277.89	280.53	283.16	285.79	288.42	291.05	293.68	296.31
FLCA	321412.39	321412.99	321413.41	321413.85	321414.29	321414.73	321415.17	321415.61	321416.05	321416.49	321416.93







MAXIMUM STORAGE = 55.

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## SUB-AREA RUNOFF COMPUTATION

SUS-PASIN C RUNOFF

```

IYDG      1
IUNG      1
TAREA     2.40
SNAP      0.00
TRSDA     2.40
TRSPC     0.00
RATIO     0.000
HYDROGRAPH DATA
ISNOW     0
ISAME     1
LOCAL     0
JPR1      0
ISTAGE     0
JAUTO     0
JPLT      1
ITAPE     0
IECON     0
ICOMP     0
ISTAQ     0
PRECIP DATA
R6        110.50
R12       122.00
R24       132.00
R48       142.00
R72       0.00
R96       0.00
SPE       0.00
PMS       21.90
TIME     15.800
TIMESE COMPUTED BY THE PROGRAM IS 15.800

```

SLIP	STKRS	OLTR	RTOL	ERAIN	STKRS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	1.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.01



[illegible]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	270.	1855.	885.	336.	24286.
CMS	67.	53.	25.	10.	688.
IN CHS		7.19	17.72	15.63	15.60
WM		182.62	348.83	397.03	398.49
AC-ET		920.	1755.	2000.	2007.
CH-W		1135.	2165.	2467.	2476.

COMBINE HYCROGRAPHS

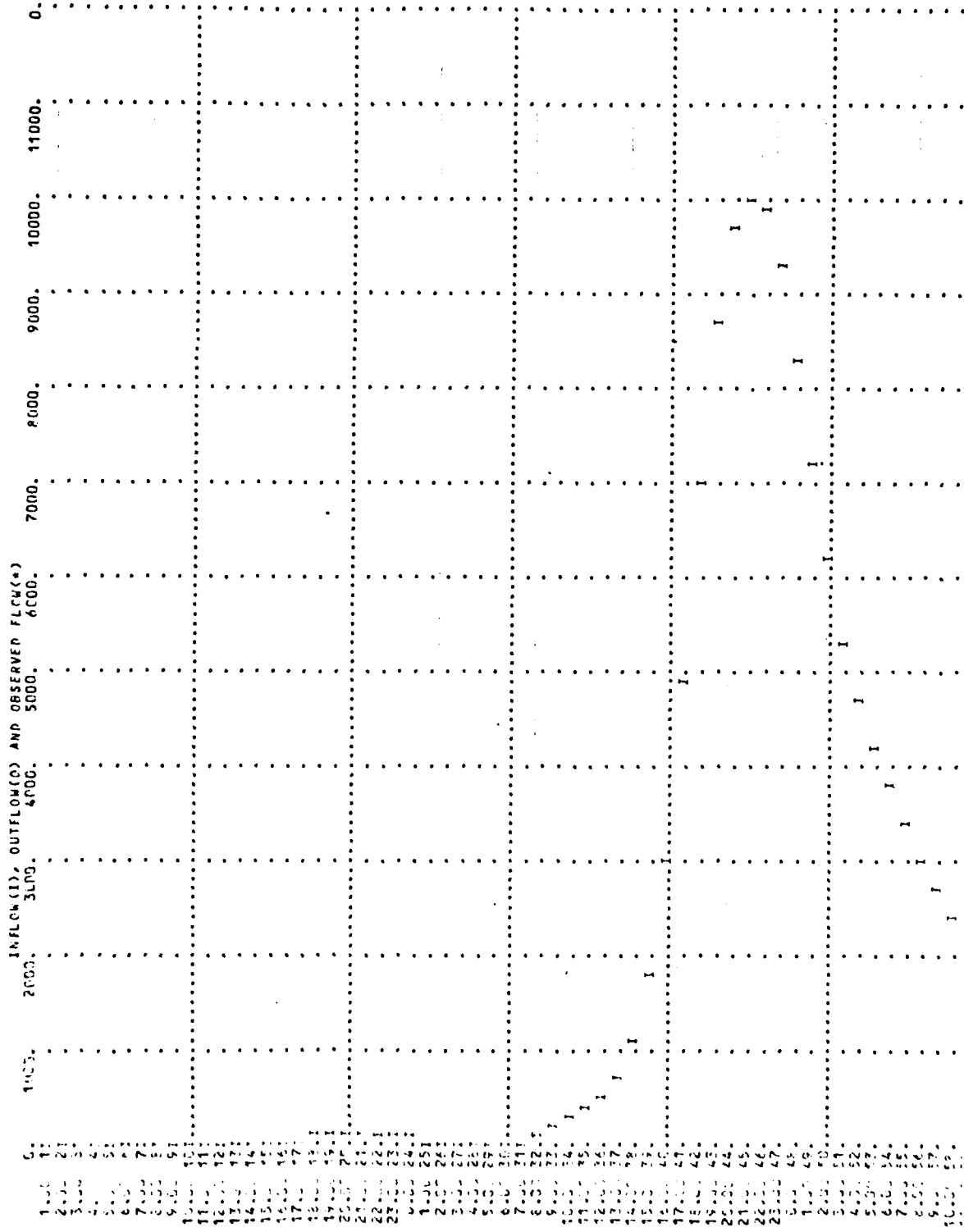
COASTLINE CHANNEL FLOW 2 SUBBASIN RUNOFF AT STN 114+00.

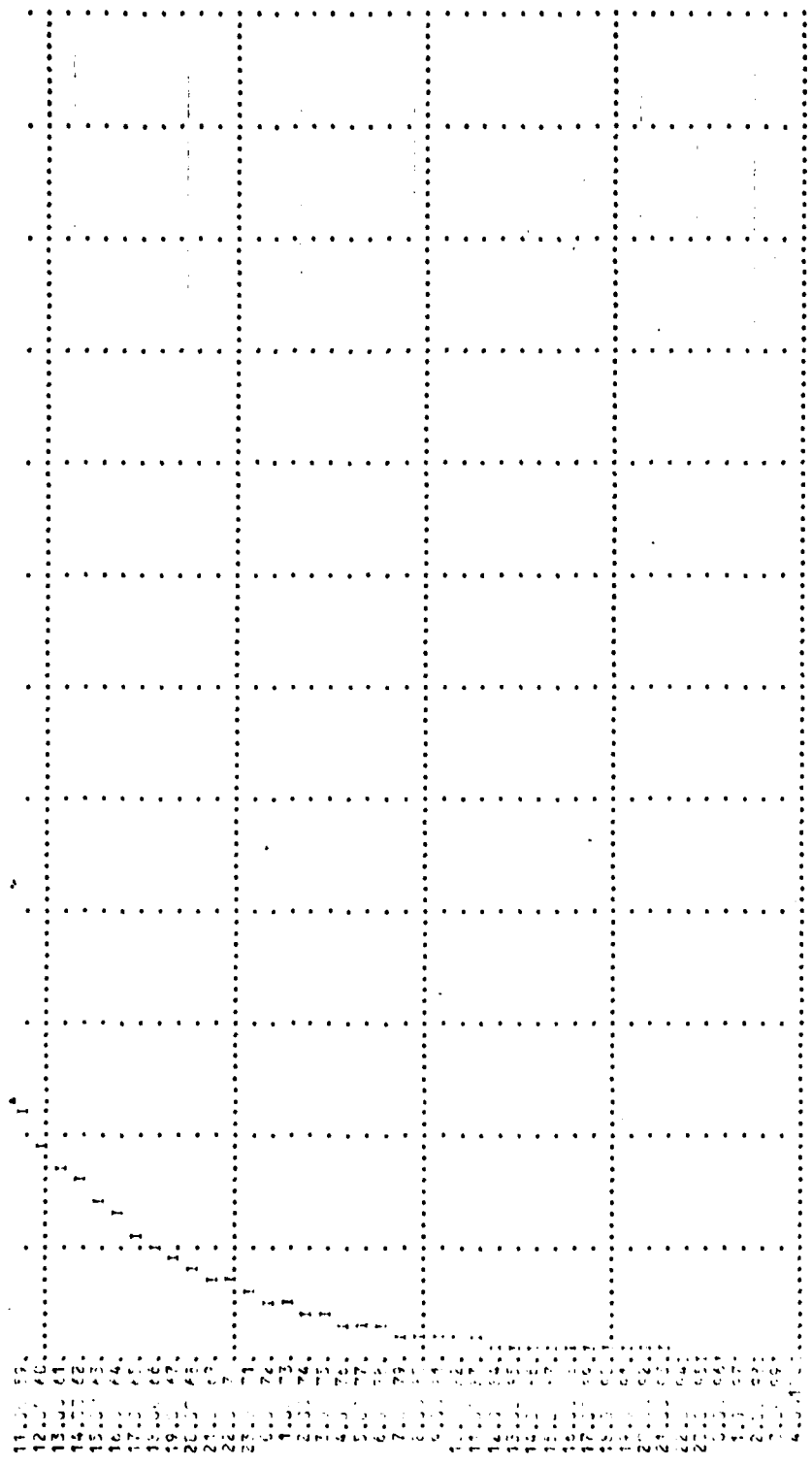
ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW	2	0	0	2	1	1	0	0

SUM OF 2 HYDROGRAPHS AT INFLOW PLAN 1 RTIO 1



# STATION INFLOW



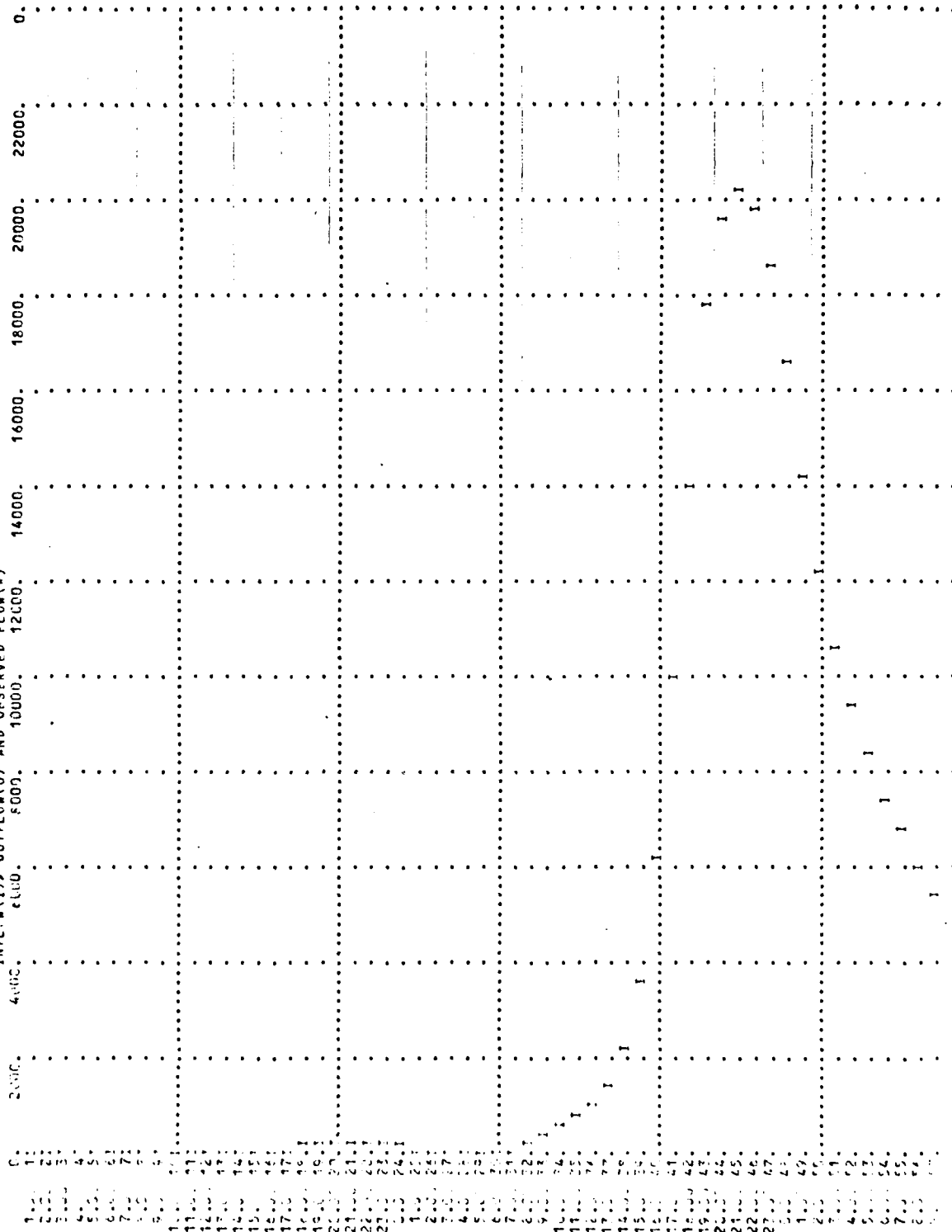




• CUF •

STATION IN FLOW

INFLW (1), OUTFLOW (2) AND OBSERVED FLOW (3)



[illegible]



1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840.

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END-OF-PERIOD HYDROGRAPH COORDINATES

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10.3.2.1  
10.3.2.2  
10.3.2.2

Section 30.37 and 14 "Secs 30.37 and 14 "Secs

VOLUME  
40672  
7983  
12.40  
315.55  
11626  
14340

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DAY.

## ROUTING

0  
AUTO

ACCAFT DEFY CHAV:EL FOUTING

750 SF

180.00

20.22  
83.38  
50.87  
85.95  
96.32  
20.00  
50.87  
85.95

ARTIC 1

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MAXIMUM STORAGE = 3.

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## HYDROGRAPH ROUTING

MINNISCEUNGO CREEK D/S HIGH TENSION WIRES

|       | ISTAQ | IComp | IECON | ITAPE        | JPLT  | JPRT  | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|--------------|-------|-------|-------|--------|-------|
|       | 21+00 | 1     | Q     | Q            | Q     | Q     | Q     | Q      | Q     |
| CLASS | C.GSS | AUG   | IRRES | ROUTING DATA | IOPT  | IPMP  | LSTR  | LSTR   |       |
| C.C   | C.C00 | C.C0  | 1     | ISAME        | Q     | Q     | Q     | Q      |       |
|       | ASTPS | NSTEL | LAG   | AFSKK        | X     | TSK   | STOPA | ISPRT  |       |
|       | 1     | Q     | Q     | Q.C00        | Q.Q00 | Q.Q00 | Q.    | Q      |       |

RECEIVED 1967- CHANNEL ROUTING

| GW(1) | GW(2) | GW(3) | ELNVT | ELVAX | RLNTH | SEL    |
|-------|-------|-------|-------|-------|-------|--------|
| .336  | .9466 | .0300 | 146.0 | 170.0 | 1900. | .01800 |

[illegible]

| ST-REC | 6.00     | 6.00     | 139.14   | 2.30      | 5.38      | 9.57      | 14.95     | 21.53     | 30.10     | 44.10     | 66.65    |
|--------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
|        | 52.33    |          | 139.14   | 129.09    | 247.91    | 312.14    | 380.72    | 453.65    | 530.93    | 612.56    | 698.54   |
| CUTFLC | 0.00     | 64.81    | 411.54   | 1217.35   | 2613.09   | 4737.85   | 7704.27   | 10314.66  | 13349.60  | 15349.60  | 25157.90 |
|        | 4.325.55 | 61173.50 | 49736.98 | 198315.76 | 178784.95 | 238017.43 | 306177.81 | 383473.51 | 470136.95 | 566415.35 |          |





STATION 39+00  
 ELEV 111.0  
 RLNTH 1200.0  
 SEL 0.01100

CROSS SECTION COORDINATES--STA-ELEV, STA-FLW--ETC  
 2930.00 150.00 2940.00 140.00 2970.00 130.00 2980.00 120.00 3000.00 115.00  
 7130.00 120.00 7070.00 130.00 7100.00 140.00

| STATION | 39+00 | 39+10 | 39+20 | 39+30 | 39+40 | 39+50 | 39+60 | 39+70 | 39+80 | 39+90 | 40+00 | 40+10 | 40+20 | 40+30 | 40+40 | 40+50 | 40+60 | 40+70 | 40+80 | 40+90 | 41+00 | 41+10 | 41+20 | 41+30 | 41+40 | 41+50 | 41+60 | 41+70 | 41+80 | 41+90 | 42+00 | 42+10 | 42+20 | 42+30 | 42+40 | 42+50 | 42+60 | 42+70 | 42+80 | 42+90 | 43+00 | 43+10 | 43+20 | 43+30 | 43+40 | 43+50 | 43+60 | 43+70 | 43+80 | 43+90 | 44+00 | 44+10 | 44+20 | 44+30 | 44+40 | 44+50 | 44+60 | 44+70 | 44+80 | 44+90 | 45+00 | 45+10 | 45+20 | 45+30 | 45+40 | 45+50 | 45+60 | 45+70 | 45+80 | 45+90 | 46+00 | 46+10 | 46+20 | 46+30 | 46+40 | 46+50 | 46+60 | 46+70 | 46+80 | 46+90 | 47+00 | 47+10 | 47+20 | 47+30 | 47+40 | 47+50 | 47+60 | 47+70 | 47+80 | 47+90 | 48+00 | 48+10 | 48+20 | 48+30 | 48+40 | 48+50 | 48+60 | 48+70 | 48+80 | 48+90 | 49+00 | 49+10 | 49+20 | 49+30 | 49+40 | 49+50 | 49+60 | 49+70 | 49+80 | 49+90 | 50+00 | 50+10 | 50+20 | 50+30 | 50+40 | 50+50 | 50+60 | 50+70 | 50+80 | 50+90 | 51+00 | 51+10 | 51+20 | 51+30 | 51+40 | 51+50 | 51+60 | 51+70 | 51+80 | 51+90 | 52+00 | 52+10 | 52+20 | 52+30 | 52+40 | 52+50 | 52+60 | 52+70 | 52+80 | 52+90 | 53+00 | 53+10 | 53+20 | 53+30 | 53+40 | 53+50 | 53+60 | 53+70 | 53+80 | 53+90 | 54+00 | 54+10 | 54+20 | 54+30 | 54+40 | 54+50 | 54+60 | 54+70 | 54+80 | 54+90 | 55+00 | 55+10 | 55+20 | 55+30 | 55+40 | 55+50 | 55+60 | 55+70 | 55+80 | 55+90 | 56+00 | 56+10 | 56+20 | 56+30 | 56+40 | 56+50 | 56+60 | 56+70 | 56+80 | 56+90 | 57+00 | 57+10 | 57+20 | 57+30 | 57+40 | 57+50 | 57+60 | 57+70 | 57+80 | 57+90 | 58+00 | 58+10 | 58+20 | 58+30 | 58+40 | 58+50 | 58+60 | 58+70 | 58+80 | 58+90 | 59+00 | 59+10 | 59+20 | 59+30 | 59+40 | 59+50 | 59+60 | 59+70 | 59+80 | 59+90 | 60+00 | 60+10 | 60+20 | 60+30 | 60+40 | 60+50 | 60+60 | 60+70 | 60+80 | 60+90 | 61+00 | 61+10 | 61+20 | 61+30 | 61+40 | 61+50 | 61+60 | 61+70 | 61+80 | 61+90 | 62+00 | 62+10 | 62+20 | 62+30 | 62+40 | 62+50 | 62+60 | 62+70 | 62+80 | 62+90 | 63+00 | 63+10 | 63+20 | 63+30 | 63+40 | 63+50 | 63+60 | 63+70 | 63+80 | 63+90 | 64+00 | 64+10 | 64+20 | 64+30 | 64+40 | 64+50 | 64+60 | 64+70 | 64+80 | 64+90 | 65+00 | 65+10 | 65+20 | 65+30 | 65+40 | 65+50 | 65+60 | 65+70 | 65+80 | 65+90 | 66+00 | 66+10 | 66+20 | 66+30 | 66+40 | 66+50 | 66+60 | 66+70 | 66+80 | 66+90 | 67+00 | 67+10 | 67+20 | 67+30 | 67+40 | 67+50 | 67+60 | 67+70 | 67+80 | 67+90 | 68+00 | 68+10 | 68+20 | 68+30 | 68+40 | 68+50 | 68+60 | 68+70 | 68+80 | 68+90 | 69+00 | 69+10 | 69+20 | 69+30 | 69+40 | 69+50 | 69+60 | 69+70 | 69+80 | 69+90 | 70+00 | 70+10 | 70+20 | 70+30 | 70+40 | 70+50 | 70+60 | 70+70 | 70+80 | 70+90 | 71+00 | 71+10 | 71+20 | 71+30 | 71+40 | 71+50 | 71+60 | 71+70 | 71+80 | 71+90 | 72+00 | 72+10 | 72+20 | 72+30 | 72+40 | 72+50 | 72+60 | 72+70 | 72+80 | 72+90 | 73+00 | 73+10 | 73+20 | 73+30 | 73+40 | 73+50 | 73+60 | 73+70 | 73+80 | 73+90 | 74+00 | 74+10 | 74+20 | 74+30 | 74+40 | 74+50 | 74+60 | 74+70 | 74+80 | 74+90 | 75+00 | 75+10 | 75+20 | 75+30 | 75+40 | 75+50 | 75+60 | 75+70 | 75+80 | 75+90 | 76+00 | 76+10 | 76+20 | 76+30 | 76+40 | 76+50 | 76+60 | 76+70 | 76+80 | 76+90 | 77+00 | 77+10 | 77+20 | 77+30 | 77+40 | 77+50 | 77+60 | 77+70 | 77+80 | 77+90 | 78+00 | 78+10 | 78+20 | 78+30 | 78+40 | 78+50 | 78+60 | 78+70 | 78+80 | 78+90 | 79+00 | 79+10 | 79+20 | 79+30 | 79+40 | 79+50 | 79+60 | 79+70 | 79+80 | 79+90 | 80+00 | 80+10 | 80+20 | 80+30 | 80+40 | 80+50 | 80+60 | 80+70 | 80+80 | 80+90 | 81+00 | 81+10 | 81+20 | 81+30 | 81+40 | 81+50 | 81+60 | 81+70 | 81+80 | 81+90 | 82+00 | 82+10 | 82+20 | 82+30 | 82+40 | 82+50 | 82+60 | 82+70 | 82+80 | 82+90 | 83+00 | 83+10 | 83+20 | 83+30 | 83+40 | 83+50 | 83+60 | 83+70 | 83+80 | 83+90 | 84+00 | 84+10 | 84+20 | 84+30 | 84+40 | 84+50 | 84+60 | 84+70 | 84+80 | 84+90 | 85+00 | 85+10 | 85+20 | 85+30 | 85+40 | 85+50 | 85+60 | 85+70 | 85+80 | 85+90 | 86+00 | 86+10 | 86+20 | 86+30 | 86+40 | 86+50 | 86+60 | 86+70 | 86+80 | 86+90 | 87+00 | 87+10 | 87+20 | 87+30 | 87+40 | 87+50 | 87+60 | 87+70 | 87+80 | 87+90 | 88+00 | 88+10 | 88+20 | 88+30 | 88+40 | 88+50 | 88+60 | 88+70 | 88+80 | 88+90 | 89+00 | 89+10 | 89+20 | 89+30 | 89+40 | 89+50 | 89+60 | 89+70 | 89+80 | 89+90 | 90+00 | 90+10 | 90+20 | 90+30 | 90+40 | 90+50 | 90+60 | 90+70 | 90+80 | 90+90 | 91+00 | 91+10 | 91+20 | 91+30 | 91+40 | 91+50 | 91+60 | 91+70 | 91+80 | 91+90 | 92+00 | 92+10 | 92+20 | 92+30 | 92+40 | 92+50 | 92+60 | 92+70 | 92+80 | 92+90 | 93+00 | 93+10 | 93+20 | 93+30 | 93+40 | 93+50 | 93+60 | 93+70 | 93+80 | 93+90 | 94+00 | 94+10 | 94+20 | 94+30 | 94+40 | 94+50 | 94+60 | 94+70 | 94+80 | 94+90 | 95+00 | 95+10 | 95+20 | 95+30 | 95+40 | 95+50 | 95+60 | 95+70 | 95+80 | 95+90 | 96+00 | 96+10 | 96+20 | 96+30 | 96+40 | 96+50 | 96+60 | 96+70 | 96+80 | 96+90 | 97+00 | 97+10 | 97+20 | 97+30 | 97+40 | 97+50 | 97+60 | 97+70 | 97+80 | 97+90 | 98+00 | 98+10 | 98+20 | 98+30 | 98+40 | 98+50 | 98+60 | 98+70 | 98+80 | 98+90 | 99+00 | 99+10 | 99+20 | 99+30 | 99+40 | 99+50 | 99+60 | 99+70 | 99+80 | 99+90 | 100+00 | 100+10 | 100+20 | 100+30 | 100+40 | 100+50 | 100+60 | 100+70 | 100+80 | 100+90 | 101+00 | 101+10 | 101+20 | 101+30 | 101+40 | 101+50 | 101+60 | 101+70 | 101+80 | 101+90 | 102+00 | 102+10 | 102+20 | 102+30 | 102+40 | 102+50 | 102+60 | 102+70 | 102+80 | 102+90 | 103+00 | 103+10 | 103+20 | 103+30 | 103+40 | 103+50 | 103+60 | 103+70 | 103+80 | 103+90 | 104+00 | 104+10 | 104+20 | 104+30 | 104+40 | 104+50 | 104+60 | 104+70 | 104+80 | 104+90 | 105+00 | 105+10 | 105+20 | 105+30 | 105+40 | 105+50 | 105+60 | 105+70 | 105+80 | 105+90 | 106+00 | 106+10 | 106+20 | 106+30 | 106+40 | 106+50 | 106+60 | 106+70 | 106+80 | 106+90 | 107+00 | 107+10 | 107+20 | 107+30 | 107+40 | 107+50 | 107+60 | 107+70 | 107+80 | 107+90 | 108+00 | 108+10 | 108+20 | 108+30 | 108+40 | 108+50 | 108+60 | 108+70 | 108+80 | 108+90 | 109+00 | 109+10 | 109+20 | 109+30 | 109+40 | 109+50 | 109+60 | 109+70 | 109+80 | 109+90 | 110+00 | 110+10 | 110+20 | 110+30 | 110+40 | 110+50 | 110+60 | 110+70 | 110+80 | 110+90 | 111+00 | 111+10 | 111+20 | 111+30 | 111+40 | 111+50 | 111+60 | 111+70 | 111+80 | 111+90 | 112+00 | 112+10 | 112+20 | 112+30 | 112+40 | 112+50 | 112+60 | 112+70 | 112+80 | 112+90 | 113+00 | 113+10 | 113+20 | 113+30 | 113+40 | 113+50 | 113+60 | 113+70 | 113+80 | 113+90 | 114+00 | 114+10 | 114+20 | 114+30 | 114+40 | 114+50 | 114+60 | 114+70 | 114+80 | 114+90 | 115+00 | 115+10 | 115+20 | 115+30 | 115+40 | 115+50 | 115+60 | 115+70 | 115+80 | 115+90 | 116+00 | 116+10 | 116+20 | 116+30 | 116+40 | 116+50 | 116+60 | 116+70 | 116+80 | 116+90 | 117+00 | 117+10 | 117+20 | 117+30 | 117+40 | 117+50 | 117+60 | 117+70 | 117+80 | 117+90 | 118+00 | 118+10 | 118+20 | 118+30 | 118+40 | 118+50 | 118+60 | 118+70 | 118+80 | 118+90 | 119+00 | 119+10 | 119+20 | 119+30 | 119+40 | 119+50 | 119+60 | 119+70 | 119+80 | 119+90 | 120+00 | 120+10 | 120+20 | 120+30 | 120+40 | 120+50 | 120+60 | 120+70 | 120+80 | 120+90 | 121+00 | 121+10 | 121+20 | 121+30 | 121+40 | 121+50 | 121+60 | 121+70 | 121+80 | 121+90 | 122+00 | 122+10 | 122+20 | 122+30 | 122+40 | 122+50 | 122+60 | 122+70 | 122+80 | 122+90 | 123+00 | 123+10 | 123+20 | 123+30 | 123+40 | 123+50 | 123+60 | 123+70 | 123+80 | 123+90 | 124+00 | 124+10 | 124+20 | 124+30 | 124+40 | 124+50 | 124+60 | 124+70 | 124+80 | 124+90 | 125+00 | 125+10 | 125+20 | 125+30 | 125+40 | 125+50 | 125+60 | 125+70 | 125+80 | 125+90 | 126+00 | 126+10 | 126+20 | 126+30 | 126+40 | 126+50 | 126+60 | 126+70 | 126+80 | 126+90 | 127+00 | 127+10 | 127+20 | 127+30 | 127+40 | 127+50 | 127+60 | 127+70 | 127+80 | 127+90 | 128+00 | 128+10 | 128+20 | 128+30 | 128+40 | 128+50 | 128+60 | 128+70 | 128+80 | 128+90 | 129+00 | 129+10 | 129+20 | 129+30 | 129+40 | 129+50 | 129+60 | 129+70 | 129+80 | 129+90 | 130+00 | 130+10 | 130+20 | 130+30 | 130+40 | 130+50 | 130+60 | 130+70 | 130+80 | 130+90 | 131+00 | 131+10 | 131+20 | 131+30 | 131+40 | 131+50 | 131+60 | 131+70 | 131+80 | 131+90 | 132+00 | 132+10 | 132+20 | 132+30 | 132+40 | 132+50 | 132+60 | 132+70 | 132+80 | 132+90 | 133+00 | 133+10 | 133+20 | 133+30 | 133+40 | 133+50 | 133+60 | 133+70 | 133+80 | 133+90 | 134+00 | 134+10 | 134+20 | 134+30 | 134+40 | 134+50 | 134+60 | 134+70 | 134+80 | 134+90 | 135+00 | 135+10 | 135+20 | 135+30 | 135+40 | 135+50 | 135+60 | 135+70 | 135+80 | 135+90 | 136+00 | 136+10 | 136+20 | 136+30 | 136+40 | 136+50 | 136+60 | 136+70 | 136+80 | 136+90 | 137+00 | 137+10 | 137+20 | 137+30 | 137+40 | 137+50 | 137+60 | 137+70 | 137+80 | 137+90 | 138+00 | 138+10 | 138+20 | 138+30 | 138+40 | 138+50 | 138+60 | 138+70 | 138+80 | 138+90 | 139+00 | 139+10 | 139+20 | 139+30 | 139+40 | 139+50 | 139+60 | 139+70 | 139+80 | 139+90 | 140+00 | 140+10 | 140+20 | 140+30 | 140+40 | 140+50 | 140+60 | 140+70 | 140+80 | 140+90 | 141+00 | 141+10 | 141+20 | 141+30 | 141+40 | 141+50 | 141+60 | 141+70 | 141+80 | 141+90 | 142+00 | 142+10 | 142+20 | 142+30 | 142+40 | 142+50 | 142+60 | 142+70 | 142+80 | 142+90 | 143+00 | 143+10 | 143+20 | 143+30 | 143+40 | 143+50 | 143+60 | 143+70 | 143+80 | 143+90 | 144+00 | 144+10 | 144+20 | 144+30 | 144+40 | 144+50 | 144+60 | 144+70 | 144+80 | 144+90 | 145+00 | 145+10 | 145+20 | 145+30 | 145+40 | 145+50 | 145+60 | 145+70 | 145+80 | 145+90 | 146+00 | 146+10 | 146+20 | 146+30 | 146+40 | 146+50 | 146+60 | 146+70 | 146+80 | 146+90 | 147+00 | 147+10 | 147+20 | 147+30 | 147+40 | 147+50 | 147+60 | 147+70 | 147+80 | 147+90 | 148+00 | 148+10 | 148+20 | 148+30 | 148+40 | 148+50 | 148+60 | 148+70 | 148+80 | 148+90 | 149+00 | 149+10 | 149+20 | 149+30 | 149+40 | 149+50 | 149+60 | 149+70 | 149+80 | 149+90 | 150+00 | 150+10 | 150+20 | 150+30 | 150+40 | 150+50 | 150+60 | 150+70 | 150+80 | 150+90 | 151+00 | 151+10 | 151+20 | 151+30 | 151+40 | 151+50 | 151+60 | 151+70 | 151+80 | 151+90 | 152+00 | 152+10 | 152+20 | 152+30 | 152+40 | 152+50 | 152+60 | 152+70 | 152+80 | 152+90 | 153+00 | 153+10 | 153+20 | 153+30 | 153+40 | 153+50 | 153+60 | 153+70 | 153+80 | 153+90 | 154+00 | 154+10 | 154+2 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-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|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-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257.  
2887.

231  
28553.

231  
28553.

231  
28553.

MAXIMUM STORAGE = 43.

MAXIMUM STAGE IS 131.6

STATION 39+00, PLAN 1, RTIO 2

| OUTFLOW | 4.     | 7.    | 4.    | 6.    | 5.    |
|---------|--------|-------|-------|-------|-------|
| 9.      | 4.     | 10.   | 23.   | 47.   | 83.   |
| 5.      | 6.     | 44.   | 39.   | 36.   | 34.   |
| 54.     | 50.    | 426.  | 587.  | 622.  | 1543. |
| 200.    | 305.   | 9468. | 8696. | 7415. | 6310. |
| 9562.   | 10041. | 2837. | 2529. | 2273. | 2035. |
| 3862.   | 3524.  | 3136. | 856.  | 760.  | 687.  |
| 1322.   | 1120.  | 1767. | 331.  | 267.  | 241.  |
| 460.    | 411.   | 372.  | 112.  | 100.  | 80.   |
| 155.    | 139.   | 125.  | 34.   | 27.   | 27.   |
| 52.     | 47.    | 38.   |       |       |       |

STOR

| STOR | 0.  | 0.  | 0.  | 0.  | 0.  |
|------|-----|-----|-----|-----|-----|
| 0.   | 0.  | 0.  | 0.  | 0.  | 0.  |
| 0.   | 0.  | 0.  | 0.  | 0.  | 0.  |
| 1.   | 1.  | 0.  | 0.  | 0.  | 0.  |
| 1.   | 1.  | 0.  | 0.  | 0.  | 0.  |
| 1.   | 1.  | 0.  | 0.  | 0.  | 0.  |
| 2.   | 2.  | 0.  | 0.  | 0.  | 0.  |
| 26.  | 26. | 25. | 23. | 21. | 19. |
| 13.  | 13. | 11. | 10. | 9.  | 9.  |
| 7.   | 6.  | 5.  | 4.  | 4.  | 4.  |
| 3.   | 3.  | 2.  | 2.  | 2.  | 2.  |
| 1.   | 1.  | 1.  | 1.  | 1.  | 1.  |
| 1.   | 1.  | 0.  | 0.  | 0.  | 0.  |

STAGE

| STAGE | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
|-------|-------|-------|-------|-------|-------|
| 117.0 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 116.1 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 115.9 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 115.2 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 114.6 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 114.2 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 123.2 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 124.7 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 121.2 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 121.1 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 119.1 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 117.7 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 117.6 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |
| 116.9 | 115.1 | 115.2 | 115.3 | 115.4 | 115.5 |

| PEAK       | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|------------|--------|---------|---------|--------------|
| CFS        | 9236.  | 5123.   | 1945.   | 140702.      |
| CMS        | 262.   | 145.    | 55.     | 3984.        |
| INCHES     | 4.91   | 10.89   | 12.41   | 12.47        |
| WM         | 124.70 | 276.68  | 315.14  | 316.62       |
| AC-FT      | 4580.  | 10162.  | 11574.  | 11628.       |
| THOUS CU M | 5649.  | 12534.  | 14276.  | 14343.       |

MAXIMUM STORAGE = 26.

MAXIMUM STAGE IS 127.5

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

PLAN 1 PLAN 2  
 1.00 .50

| STATION | AREA  | PLAN | RATIO   | PLAN | RATIO   |
|---------|-------|------|---------|------|---------|
| 1       | 2.21  | 1    | 221.    | 1    | 441.    |
| 2       | 21.24 | (    | 261.12) | (    | 170.56) |
| 3       | 4.60  | 1    | 833.    | 1    | 416.    |
| 4       | 17.77 | (    | 236.05) | (    | 116.02) |
| 5       | 15.15 | 1    | 1740.   | 1    | 870.    |
| 6       | 39.11 | (    | 492.73) | (    | 246.35) |
| 7       | 15.15 | 1    | 1741.   | 1    | 873.    |
| 8       | 39.11 | (    | 493.17) | (    | 247.20) |
| 9       | 15.15 | 1    | 1745.   | 1    | 873.    |
| 10      | 39.11 | (    | 494.28) | (    | 247.56) |
| 11      | 15.15 | 1    | 1743.   | 1    | 872.    |
| 12      | 39.11 | (    | 495.35) | (    | 247.15) |
| 13      | 2.40  | 1    | 474.    | 1    | 237.    |
| 14      | 6.22  | (    | 134.24) | (    | 67.12)  |
| 15      | 17.50 | 1    | 2019.   | 1    | 1009.   |
| 16      | 45.32 | (    | 569.71) | (    | 284.84) |
| 17      | 17.50 | 1    | 2002.   | 1    | 996.    |
| 18      | 45.32 | (    | 568.60) | (    | 283.06) |
| 19      | 17.50 | 1    | 2008.   | 1    | 1000.   |
| 20      | 45.32 | (    | 568.66) | (    | 283.10) |
| 21      | 17.50 | 1    | 2006.   | 1    | 1002.   |
| 22      | 45.32 | (    | 568.07) | (    | 283.84) |
| 23      | 17.50 | 1    | 2005.   | 1    | 1004.   |
| 24      | 45.32 | (    | 567.80) | (    | 284.32) |

PLAN 1 STATION 18+00

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|-------------------|-------------------|------------|
| 1.00  | 17416.            | 338.3             | 46.00      |
| .50   | 8733.             | 336.0             | 46.00      |

PLAN 1 STATION 76+00

| MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------------------|-------------------|------------|
| 17416.            | 338.3             | 46.00      |
| 8733.             | 336.0             | 46.00      |

1.00 17455. 279.3 46.00  
.50 8735. 277.2 46.00

PLAN 1 STATION 114+0

| RATIO | MAXIMUM<br>FLOW, CFS | MAXIMUM<br>STAGE, FT | TIME<br>HOURS |
|-------|----------------------|----------------------|---------------|
|       |                      |                      |               |
| 1.00  | 17493.               | 223.2                | 46.00         |
| .50   | 8728.                | 220.2                | 46.00         |

# SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1             |                                   | ELEVATION                    |                             | INITIAL VALUE             |                               | SPILLWAY CPEST                  |                             | TOP OF DAM |  |
|--------------------|-----------------------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|---------------------------------|-----------------------------|------------|--|
|                    |                                   | STORAGE                      |                             | 210.00                    |                               | 210.00                          |                             | 216.90     |  |
|                    |                                   | OUTFLOW                      |                             | 100.                      |                               | 100.                            |                             | 199.       |  |
|                    |                                   |                              |                             | 0.                        |                               | 0.                              |                             | 3025.      |  |
| RATIO<br>OF<br>POT | MAXIMUM<br>RESERVOIR<br>W.S. ELEV | MAXIMUM<br>DEPTH<br>OVER DAM | MAXIMUM<br>STORAGE<br>AC-FT | MAXIMUM<br>OUTFLOW<br>CFS | DURATION<br>OVER TOP<br>HOURS | TIME OF<br>MAX OUTFLOW<br>HOURS | TIME OF<br>FAILURE<br>HOURS |            |  |
|                    |                                   |                              |                             |                           |                               |                                 |                             |            |  |
| 1.00               | 222.57                            | 5.07                         | 310.                        | 20080.                    | 21.00                         | 45.00                           | 0.00                        |            |  |
| .50                | 215.74                            | 2.54                         | 255.                        | 9996.                     | 13.00                         | 45.00                           | 0.00                        |            |  |

## PLAN 1 STATION 2+00

| RATIO | MAXIMUM<br>FLOW, CFS | MAXIMUM<br>STAGE, FT | TIME<br>HOURS |  |  |
|-------|----------------------|----------------------|---------------|--|--|
|       |                      |                      |               |  |  |
| 1.00  | 20082.               | 184.6                | 45.00         |  |  |
| .50   | 10001.               | 184.0                | 45.00         |  |  |

## PLAN 1 STATION 21+00

| RATIO | MAXIMUM<br>FLOW, CFS | MAXIMUM<br>STAGE, FT | TIME<br>HOURS |  |  |
|-------|----------------------|----------------------|---------------|--|--|
|       |                      |                      |               |  |  |
| 1.00  | 20061.               | 153.4                | 45.00         |  |  |
| .50   | 10024.               | 150.9                | 45.00         |  |  |

## PLAN 1 STATION 39+00

| RATIO | MAXIMUM<br>FLOW, CFS | MAXIMUM<br>STAGE, FT | TIME<br>HOURS |  |  |
|-------|----------------------|----------------------|---------------|--|--|
|       |                      |                      |               |  |  |
| 1.00  | 20052.               | 131.6                | 45.00         |  |  |
| .50   | 10041.               | 127.5                | 45.00         |  |  |

STABILITY ANALYSIS

APPENDIX E

# TAMS

Job No. 1557-10

Project New York Dam Inspection GARNERVILLE

Subject Stability Analysis

Sheet 1 of 23

Date 6-2-80

By JJF

Ch'k. by \_\_\_\_\_

## Assumptions

- 1) The unit weight of masonry is assumed to be 165 lbs/cuft
  - 2) Ice load of 5000 lbs/ft<sup>2</sup> acting about 1 ft from top of dam (COE Criteria)
  - 3) Angle of internal resistance of soil (fill) is assumed to be 35° based on observations and engineering judgment
  - 4) Dam Site is in Seismic Zone 2
  - 5) At rest E.P.P. Pressure for upstream Fill
- LOADING Conditions

CASE I - Normal loading; Lake level at top of crest El. 210. No Ice load.

CASE II - Normal loading; Lake level at top of crest El. 210. 5000 lbs/ft<sup>2</sup> Ice load.

CASE III - Unusual loading; Lake level at 1/2 P.M.F.

CASE IV - Extreme loading; Lake level at P.M.F.

CASE V - Unusual loading; Lake level at 1/2 P.M.F. crest and earthquake force of 0.05g.

# TAMS

Job No. 1551  
Project New York Dam Inspections - GARNERVILLE  
Subject Stability Analysis

Sheet 2 of 23  
Date 6-2-80  
By JTF  
Ch'k. by \_\_\_\_\_

## Stability Criteria

- a) overturning - Resultant force shall fall within the middle third of the base for cases I and II and the resultant force shall fall within the middle half of base for cases III, IV, and V
- b) Sliding For case I+II, Friction factor of safety against sliding is to be 1.5 For case III, V Friction factor of safety against sliding is to be 1.25. For case IV friction factor of safety is to be 1.1

AD-A092 042

NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13  
NATIONAL DAM SAFETY PROGRAM, GARNERVILLE DAM (INVENTORY NUMBER --E+C(U)  
AUG 80 E O'BRIEN DACW51-79-C-0001

UNCLASSIFIED

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2 of 2

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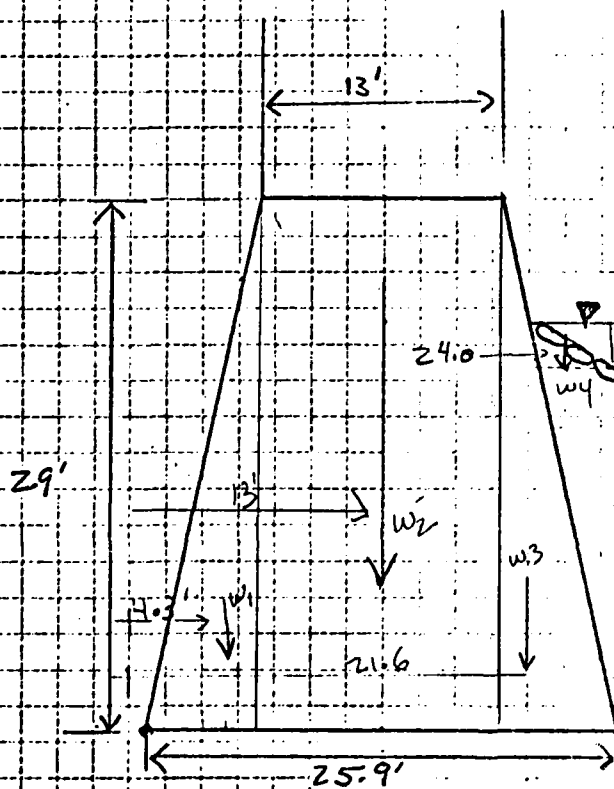
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# TAMS

Job No. 1551-10  
 Project NYS Dam Inspection  
 Subject GARNERVILLE DAM - Stability Analysis  
NON-OVER FLOW SECTION

Sheet 3 of 23  
 Date 6-2-80  
 By JTF  
 Ch'k. by \_\_\_\_\_

Dead loads



Scale 1" = 10'

$\Sigma m$  about Toe

|   |         |                       |                   |     |          |
|---|---------|-----------------------|-------------------|-----|----------|
| $w_1 = \frac{1}{2}(2.9)(6.45)(0.165) =$ | $15.43$ | $\times$              | $\frac{MA.}{4.3}$ | $=$ | $66.35$  |
| $w_2 = \frac{1}{2}(13)(2.9)(0.165) =$   | $62.2$  | $\times$              | $13.0$            | $=$ | $808.9$  |
| $w_3 = \frac{1}{2}(2.9)(6.45)(0.165) =$ | $15.43$ | $\times$              | $21.6$            | $=$ | $333.32$ |
| $w_4 = \frac{1}{2}(2.3)(4)(0.25) =$     | $5.75$  | $\times$              | $24.0$            | $=$ | $138.0$  |
| $\Sigma FY = 98.81$                     |         | $\Sigma MF = 1346.34$ |                   |     |          |

$$\bar{N} = \frac{1346.34}{98.81} = 13.63 - \text{OK within middle } 1/2$$

$$\bar{y} = 12.90 \text{ ft.}$$

# TAMS

Job No. 1551-10

Project NYS Dam. Inspection

Subject GARNERVILLE DAM - Stability Analysis

Sheet 4 of 23

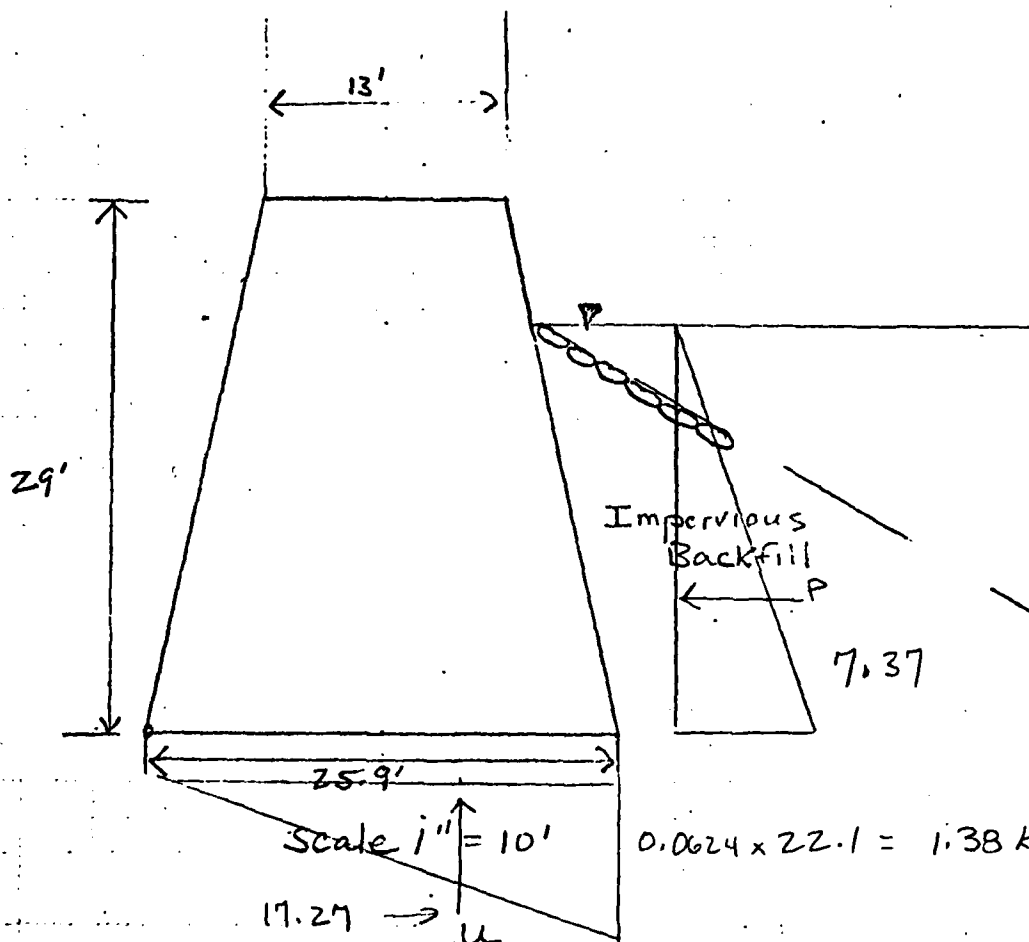
Date 6-2-80

By JJF

Ch'k. by \_\_\_\_\_

Hydrostatic Forces

a) - NORMAL LOADING



$\sum M_{TOE} =$

$$P = \frac{1}{2} \times 1.38 \times 22.1 =$$

$$\frac{K}{15.25} \times \frac{M.A.}{7.37} = \frac{KF}{112.39}$$

$$U = \frac{1}{2} \times 1.38 \times 25.9 =$$

$$\frac{17.87}{421.00} \times 17.27 = \frac{308.61}{421.00}$$

$$F_V \uparrow \quad 17.87$$

$$F_H \leftarrow \quad 15.25$$

$$M_o = \quad 421.00$$

# TAMS

Job No. 1551-10

Sheet 5 of 13

Project NYS Dam Inspection

Date 6-2-80

Subject GARNEVILLE DAM - Stability Analysis

By JJF

Ch'k. by \_\_\_\_\_

## EARTH Forces

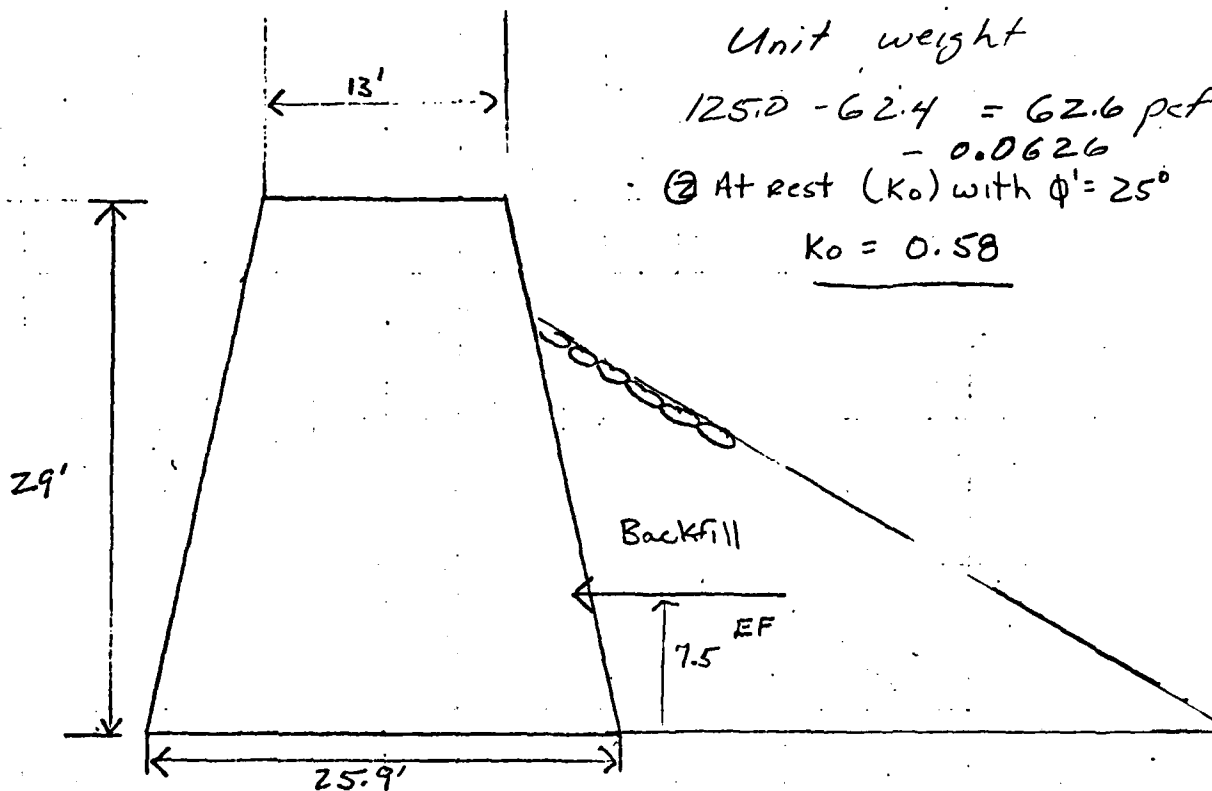
Assumed ① Submerged  
Unit weight

$$125.0 - 62.4 = 62.6 \text{ pcf}$$

$$- 0.0626$$

② At rest ( $K_0$ ) with  $\phi' = 25^\circ$

$$K_0 = 0.58$$



Scale 1" = 10'

$$EF = (0.6) \frac{1}{2} (45) (17.5) (0.0626) = \frac{K}{14.3}$$

$$\frac{MA}{7.5}$$

$$\frac{KF}{107.25}$$

## ICE LOAD

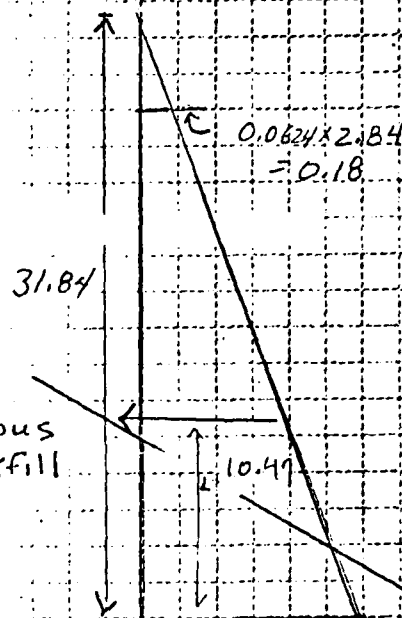
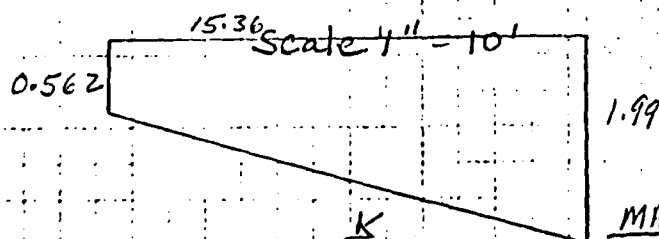
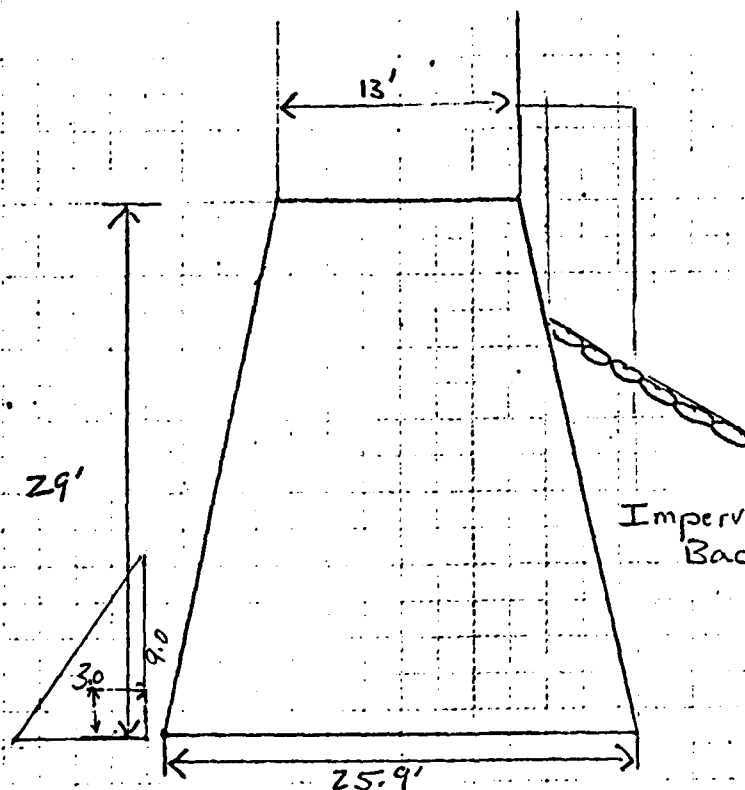
$$\frac{K}{5.0} \times \frac{MA}{21.6} = \frac{KF}{100}$$

# TAMS

Job No. 1551-10  
 Project NYS Dam Inspection  
 Subject GARNERVILLE DAM - Stability Analysis

Sheet 6 of 23  
 Date 6-2-80  
 By JJF  
 Ch'k. by \_\_\_\_\_

1/2 PMF wselevation = 219.74



$$P_H = \frac{1.99 + 0.18}{2} (29) = 31.47 \leftarrow \times \quad \frac{MA}{10.47}$$

$$P_T = \frac{1}{2} (0.562) (9.0) (0.6) = 1.57 \rightarrow \times \quad 3.0$$

$$U = \frac{1.99 + 0.562}{2} (25.9) = 33.05 \uparrow \times \quad 15.36$$

$$W_w = 0.0624 \left( (5 \times 9.8) + \frac{9.8 \times 2.8 (1.5)}{2} \right) = 3.65 \times \quad 24.0$$

$$\leftarrow F_H = 29.95$$

$$\uparrow F_V = 29.4$$

$$M_O = 329.49 \quad M_R = 4.55$$

$$507.62$$

$$\frac{837.11}{87.55} = 92.10$$

# TAMS

Job No.: 1551-10

Project NYS Dam Inspection

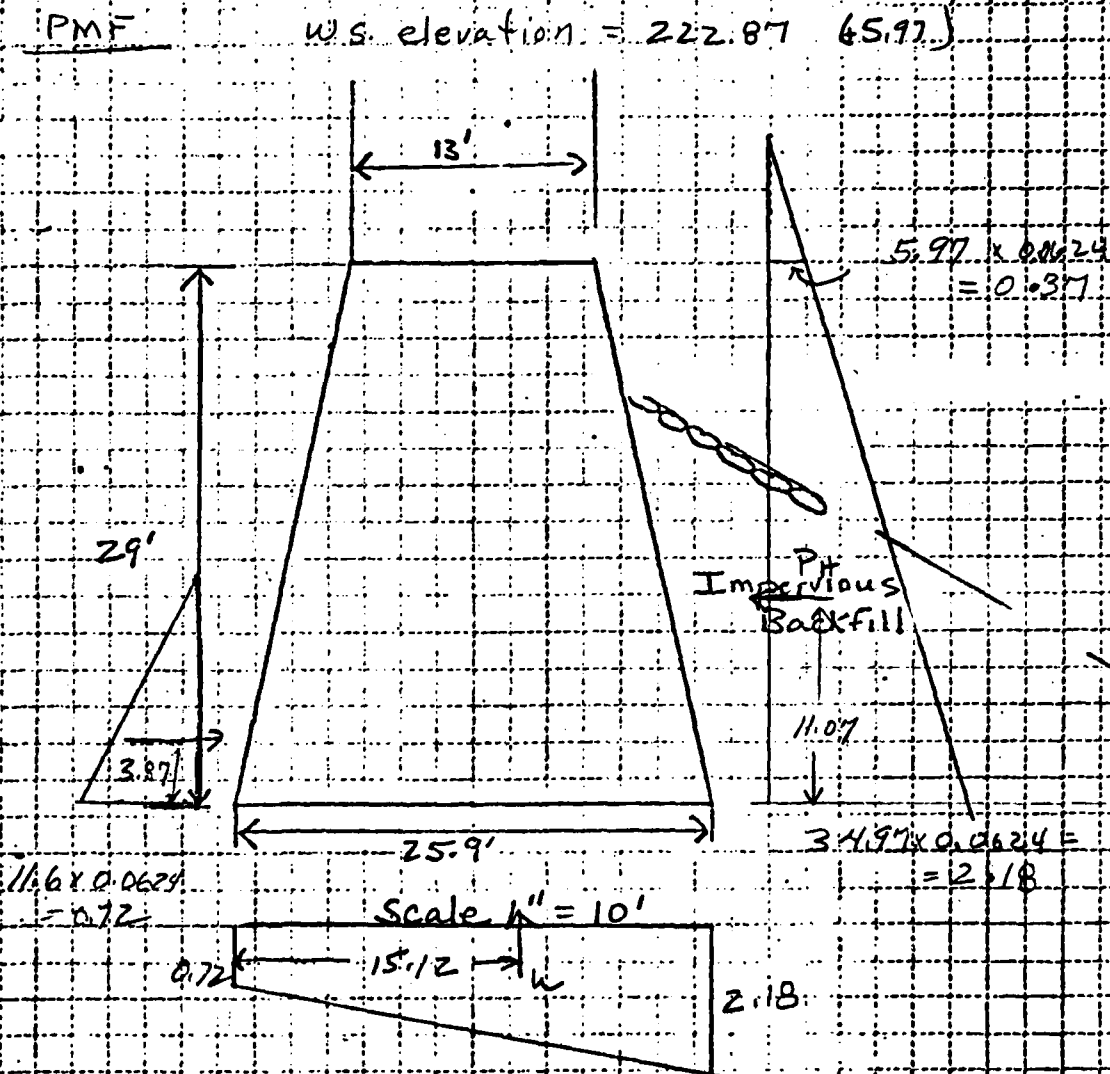
**Subject** GARNERVILLE DAM - Stability Analysis

Sheet 7 of 23

Date 6-2-80

By JJA

**Ch'k. by**



$$P_H = \frac{2.18 + 0.37 \cdot (29)}{2}$$

$$P_T = \frac{1}{2} (0.22)(1/6)(0.6) =$$

$$u = \frac{2.18 + 0.72(2.59)}{2} =$$

$$W_w = \frac{5 \times 12.45 \times 0.1574 + 12.45 + 5 \times 1.5}{2} (0.624) = 4.75 \text{ k} \quad \checkmark \quad 24$$

| $K$   | $m_1$ | $m_0$ | $m_2$ |
|-------|-------|-------|-------|
| 37.01 | 11.07 | 409.1 |       |

2.51 → 3.87 9.71

37.56↑ 1512 568.02

$$F_v = 32.81 \quad F_H = 34.5$$

|        |        |
|--------|--------|
|        | 114.0  |
| 927.72 | 123.71 |

# TAMS

Job No. 1551-10

Sheet 8 of 23

Project New York Dam Insp - GARNEVILLE

Date 6-2-80

Subject Stability ANALYSIS

By JJF

Ch'k. by \_\_\_\_\_

## CASE I NORMAL LOADING - without Ice

|             | <u>F<sub>V</sub></u> | <u>F<sub>H</sub></u> | <u>M<sub>R</sub></u> | <u>M<sub>O</sub></u> |
|-------------|----------------------|----------------------|----------------------|----------------------|
| Dead LOAD   | 98.81                | 0                    | 1346.34              |                      |
| Hydrostatic | -17.87               | 15.25                |                      | 421.0                |
| EARTH FORCE |                      | 14.3                 |                      | 107.5                |
|             | <u>80.94</u>         | <u>29.55</u>         | <u>1346.34</u>       | <u>528.25</u>        |

$$\Sigma m = 1346.34 - 528.25 = 817.84$$

$$\bar{e} = \frac{25.9}{2} - \frac{817.84}{80.94}$$

$$\bar{e} = 12.95 - 10.10 = 2.85 \quad \text{OK inside middle } \frac{1}{3}$$

$$P = \frac{80.94}{25.9} \left( 1 \pm \frac{6 \times 2.85}{25.9} \right) \frac{1000}{144} = 21.7 \pm 14.3 \left. \begin{array}{l} 36.0 \\ 7.4 \end{array} \right\}$$

## Friction Factor of Safety

$$\text{FFS} \quad \frac{80.94 \times \tan 35^\circ}{29.55} = 1.92 \quad \text{OK}$$

# TAMS

Job No. 1551

Sheet 9 of 13

Project New York Dam Insp. - GARNERVILLE

Date 6-2-80

Subject Stability Analysis

By JTF

Ch'k. by \_\_\_\_\_

## CASE II NORMAL LOADING WITH ICE LOAD

|             | <u>FV</u>    | <u>FH</u>    | <u>M<sub>v</sub></u> | <u>M<sub>h</sub></u> |
|-------------|--------------|--------------|----------------------|----------------------|
| DEAD LOAD   | 98.81        | 0            | 1346.34              | —                    |
| Hydrostatic | -17.87       | 15.75        | —                    | 421.0                |
| EARTH FORCE | 0            | 14.30        | 0                    | 107.25               |
| ICE LOAD    | 0            | 5.0          | 0                    | 108.00               |
|             | <u>80.94</u> | <u>34.55</u> | <u>1346.34</u>       | <u>636.25</u>        |

$$\Sigma m = 1346.34 - 636.25 = 710.09$$

$$\bar{e} = \frac{25.9}{2} - \frac{710.09}{80.94}$$

$$\bar{e} = 12.95 - 8.77 = 4.18'$$

Resultant location  $8.77 - 8.6 = 0.17'$  OK within the middle 1/3 of base

$$\bar{p} = \frac{80.94}{25.9} \left( 1 \pm \frac{6 \times 4.18}{25.9} \right) \times \frac{1000}{144} = 21.7 \pm 21.0 \quad \begin{matrix} 42.7 \text{ Tc} \\ 0.7 \text{ heel} \end{matrix}$$

FRICTION FACTOR OF SAFETY

$$FFS = \frac{80.94 \times \tan 35^\circ}{34.55} = 1.64 \quad \underline{\text{OK}}$$

# TAMS

Job No. 155-10

Project NYS Dam Insp. GARNERVILLE

Subject Stability Analysis

Sheet 10 of 13

Date 6-7-80

By JJF OR

Ch'k. by \_\_\_\_\_

Case III -  $\frac{1}{2}$  PMF

|             | $\frac{FV}{}$ | $\frac{FH}{}$ | $\frac{MR}{}$  | $\frac{Mo}{}$ |
|-------------|---------------|---------------|----------------|---------------|
| Dead Load   | 98.81         | 0             | 1346.34        |               |
| Hydrostatic | 30.67         | 31.63         | 104.39         | 888.83        |
| Earth Force | 0             | 14.3          | 0              | 107.25        |
|             | <u>68.14</u>  | <u>45.93</u>  | <u>1450.73</u> | <u>996.08</u> |

$$\Sigma M = 1450.73 - 996.08 = 454.65$$

$$\bar{e} = \frac{25.9}{2} - \frac{454.65}{68.14} = 6.28$$

$$\frac{454.65}{68.14} - \frac{25.9}{4} = -$$

$$6.67 - 6.48 = 0.19 \quad - \text{Inside middle } \frac{1}{2} \text{ of base}$$

$$\bar{p} = \frac{68.14}{25.9} \left( 1 \pm \frac{6 \times 6.28}{25.9} \right) \frac{1000}{144} = 18.27 \pm 26.49$$

ToC 44.76  
Hed - 8.22

Friction factor of safety

$$FFS = \frac{68.14 \tan 35^\circ}{45.93} = 1.03 < 1.25$$

$\therefore$  No Good

# TAMS

Job No. 1551-10

Project NYS Dam Inspection - Garnerville

Subject Stability Analysis

Sheet 11 of 23

Date 6-2-80

By JTF

Ch'k. by \_\_\_\_\_

## Case IV PMF

|             | <u>FV</u>   | <u>EH</u>   | <u>MR</u>      | <u>Mo</u>      |
|-------------|-------------|-------------|----------------|----------------|
| Dead Load   | 98.81       |             | 1346.31        |                |
| Hydrostatic | -32.81      | 34.50       | 123.71         | 977.72         |
| Earth Force |             | 14.3        |                | 107.25         |
|             | <u>66.0</u> | <u>48.8</u> | <u>1470.05</u> | <u>1084.96</u> |

$$EM = 1470.05 - 1084.96 = 385.09$$

$$\bar{e} = \frac{25.9}{2} \frac{385.09}{66.0} = 6.62 \quad - \quad \text{No good outside middle } 1/2$$

$$\frac{385.09}{66} - \frac{25.9}{4} = -0.39$$

$$\bar{p} = \frac{66.0}{25.9} \left( 1 \pm \frac{6 \times 6.62}{25.9} \right) \frac{1000}{144} = 17.69 \pm 27.13$$

$$\therefore 44.82 \text{ (toe)} \\ -9.44 \text{ (heel)}$$

Friction Factor of Safety

$$FFS = \frac{66.0 \tan 35^\circ}{48.8} = 0.95 < 1.15 \quad \text{No good}$$

# TAMS

Job No. 155170  
 Project NYS DAM Insp WATERVILLE  
 Subject Stability Analysis

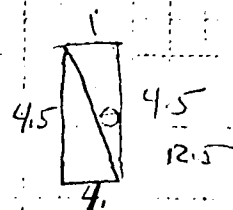
Sheet 12 of 23  
 Date 6-2-80  
 By JTF  
 Ch'k. by \_\_\_\_\_

## CASE II ; NORMAL LOADING

Zone 2 = 0.05

ZANCERS Method

$C = 0.64$   
 when  $\alpha = 12.5$



### ① Hydrodynamic Forces

$$P = 0.64 \times 0.05 \times 0.0624 \times (22.1)^2 = 0.98$$

$$M_p = (0.98) (0.4) \times 22.1 = 8.7 \text{ Kf}$$

### ② Dynamic Force

a)  $w_f = 14.1 \text{ K} \times 0.64 \times 0.05 = .46$

$$M_p = 0.46 \times 7.5 = 3.4 \text{ K}$$

b)  $w_D = 0.05 (98.81) = 4.94$

$$M_{WD} = 4.94 \text{ K} \times 12.90 = 63.73 \text{ Kf}$$

|                 | Fv     | Fh    | MR      | Mo     |
|-----------------|--------|-------|---------|--------|
| Dead Load       | 98.81  | 0     | 1346.34 |        |
| Hydrostatic     | -17.87 | 15.25 |         | 421.0  |
| EMERGENCY FORCE |        | 14.3  |         | 107.25 |
| Hydrodynamic    |        | 0.98  |         | 8.1    |
| DYNAMIC         |        | 5.4   |         | 67.13  |
|                 | 80.94  | 35.93 | 1346.34 | 604.08 |

$$EM = 1346.34 - 604.08 = 742.26$$

$$\frac{742.26}{80.94} = 9.17$$

$$\bar{e} = \frac{25.9}{2} - 9.17$$

$$= 3.78$$

OK within  
 middle 1/2  
 OK center  
 1/2

# TAMS

Job No. 1551-10

Project NYS Dam Insp - GARNEVILLE

Subject Stability Analysis

Sheet 13 of 23

Date 6-2-80

By Joel

Ch'k. by \_\_\_\_\_

Case V cont.

$$p = \frac{80.94}{25.9} \cdot \left(1 \pm \frac{6 \times 3.78}{25.9}\right) \times \frac{1000}{144} = 21.7 \pm 19 \left. \begin{array}{l} 40 \text{ psi} \\ 2.7 \text{ psi} \end{array} \right\}$$

FRICTION FACTOR OF SAFETY

$$FFS = \frac{80.94 \times \tan 35^\circ}{35.93} = 1.51 \text{ OK}$$

# TAMS

Job No. 1546-10

Project NYS State Dam Insp - GARNERVILLE

Subject Stability - Spillway section

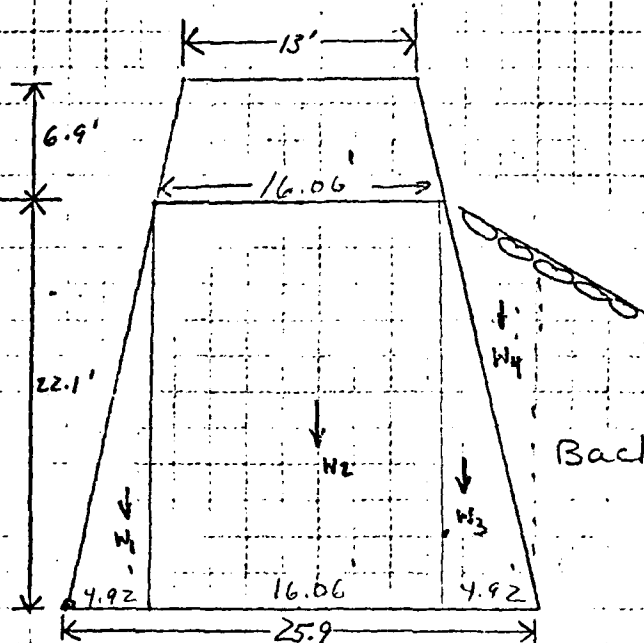
Sheet 14 of 23

Date 6-11-80

By JJF

Ch'k. by \_\_\_\_\_

Dead loads - Case 2



Scale 1" = 10'

$\Sigma M$  about Toe

|  | K            | MK    | KF             |
|--|--------------|-------|----------------|
| $w_1 = \frac{1}{2}(4.92)(22.1)(0.165) =$ | 8.97         | 3.28  | 29.42          |
| $w_2 = 16.06(22.1)(0.165) =$             | 58.56        | 12.95 | 758.33         |
| $w_3 = \frac{1}{2}(4.92)(22.1)(0.165) =$ | 8.97         | 22.62 | 202.91         |
| $w_4 = \frac{1}{2}(2.3)(4)(0.125) =$     | 5.75         | 24.0  | 138.0          |
|  | <u>82.25</u> |       | <u>1128.71</u> |

$$\bar{X} = \frac{1128.71}{82.25} = 13.72'$$

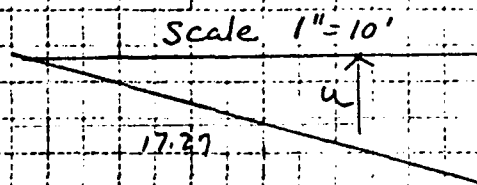
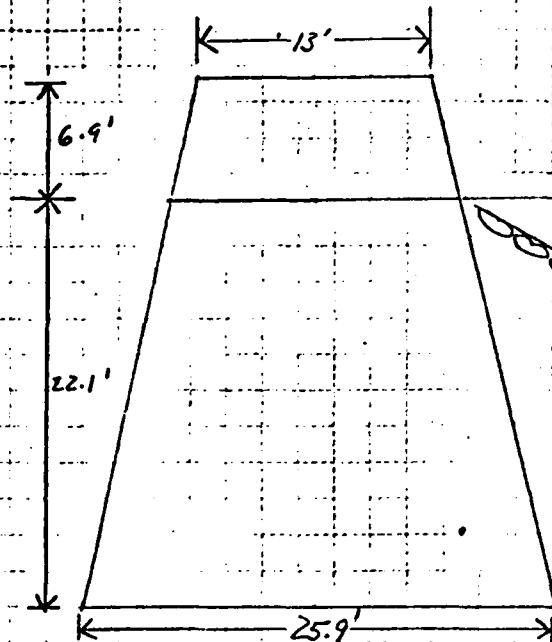
$$\bar{Y} = 11.9'$$

# TAMS

Job No. 1546-10  
 Project NYS State Dam Insp - GARNERVILLE  
 Subject Stability - Spillway Section

Sheet 15 of 3  
 Date 6-11-80  
 By JJF  
 Ch'k. by \_\_\_\_\_

Hydrostatic Forces Normal Acting - Case 2



$$0.0624 \times 22.1 = 1.38 \text{ K/ft}$$

EM TOR

|   | K     | ft   | K/ft   |
|---|-------|------|--------|
| $P = \frac{1}{2} \times 1.38 \times 22.1 =$ | 15.25 | 7.37 | 112.39 |

|   |       |       |        |
|---|-------|-------|--------|
| $u = \frac{1}{2} \times 1.38 \times 25.9 =$ | 17.87 | 17.27 | 309.61 |
|---|-------|-------|--------|

421.0

$$F_v = \uparrow 17.37 \text{ K}$$

$$F_H = \leftarrow 15.25 \text{ K}$$

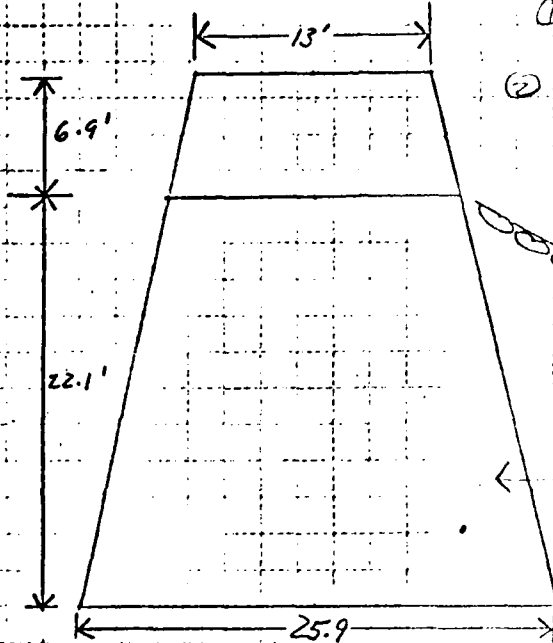
$$M = 421.00 \text{ K/ft}$$

# TAMS

Job No. 1546-10  
 Project NYS State Dam Insp - GARNERVILLE  
 Subject Stability - Spillway Section

Sheet 16 of 23  
 Date 6-11-80  
 By JJF  
 Ch'k. by \_\_\_\_\_

EARTH Forces - Case - 2



Assumed  
 ① Saturated Unit Weight  
 $125.0 - 62.4 = 62.6$  pcf  
 ② At Rest  $K_0$  with  $\phi = 25^\circ$   
 $K_0 = 0.58$

Scale 1" = 10'

$$EF = 0.58 \left( \frac{1}{2} \right) (45) (17.5) (0.0626)$$

|                 |                  |                     |
|-----------------|------------------|---------------------|
| $\frac{K}{100}$ | $\frac{EF}{100}$ | $\frac{KF}{100.25}$ |
| 1.1             | 1.1              | 1.1                 |

ICE LOAD

$$\frac{K}{51.0} = \frac{17.4}{21.6} = \frac{KF}{108.0}$$

# TAMS

Job No. 1546-10

Project NYS State Dam Insp - GARNERVILLE

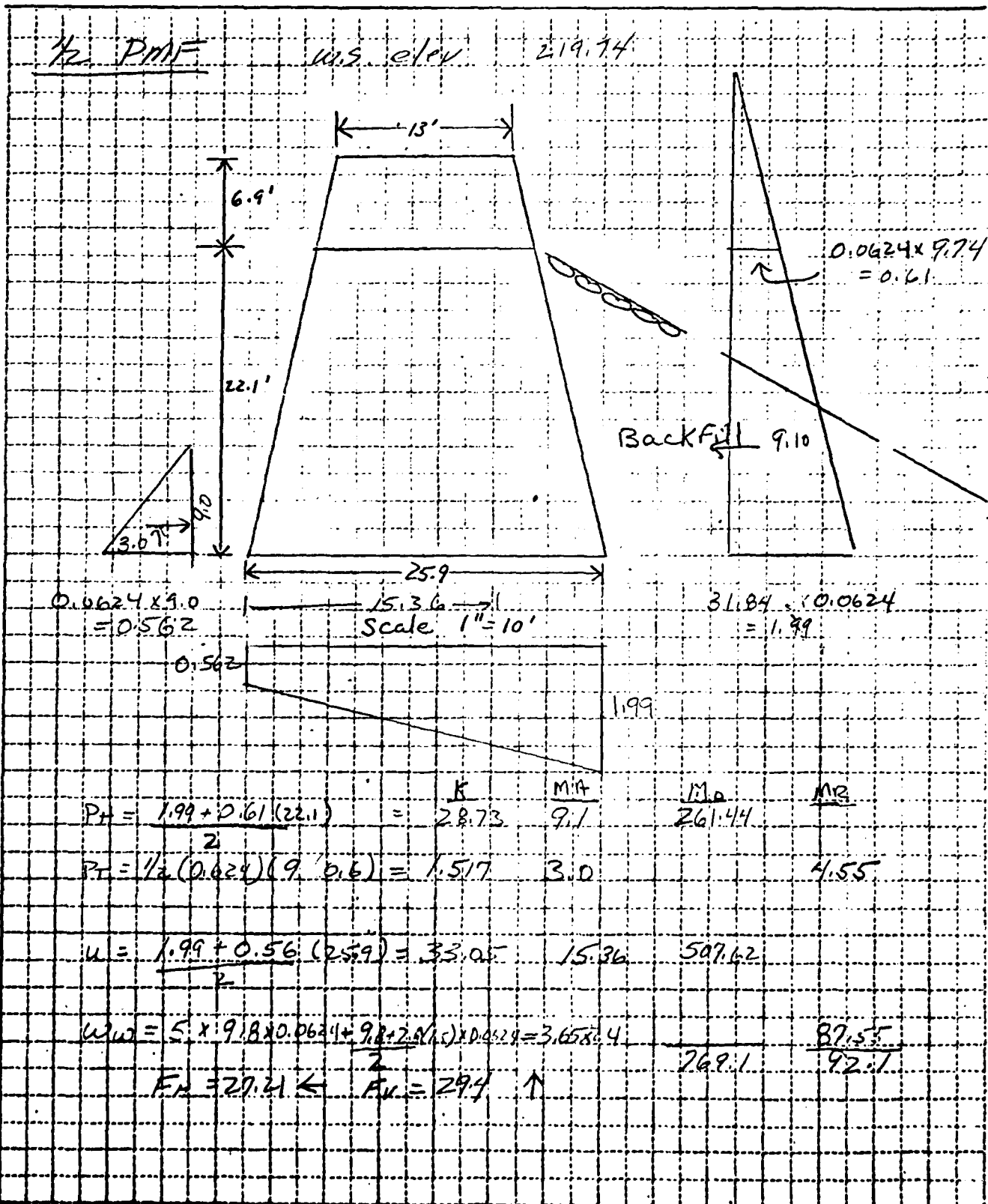
Subject Stability - Spillway section

Sheet 17 of 23

Date 6-11-80

By JTF

Ch'k. by \_\_\_\_\_



# TAMS

Job No. 1546-10

Project NYS State Dam Insp - GARNERVILLE

Subject Stability - Spillway Section

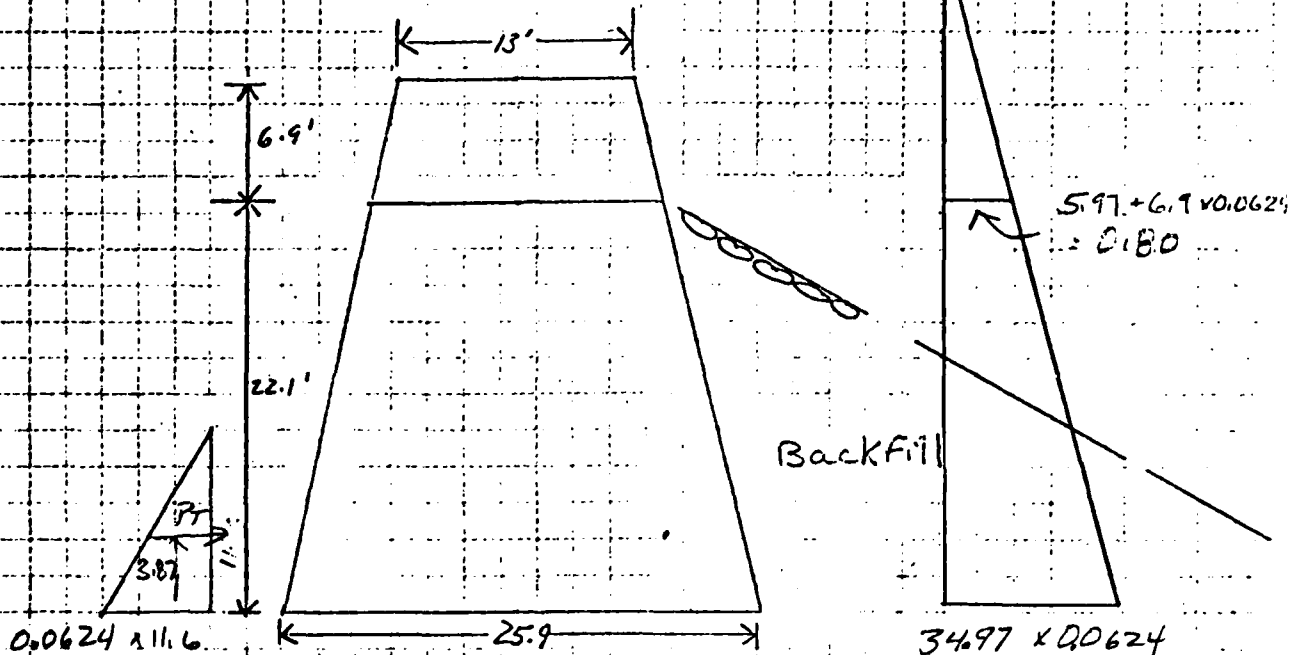
Sheet 18 of 23

Date 6-11-80

By JTF

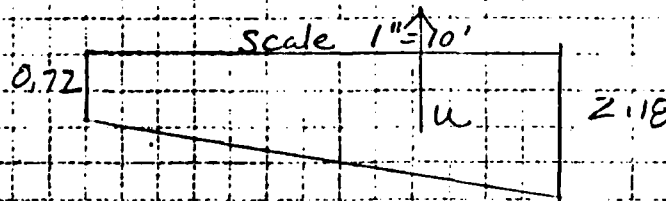
Ch'k. by \_\_\_\_\_

PMF W.S. ELEV 222.87 (159.7)



$$0.0624 \times 11.6 = 0.72$$

$$34.97 \times 0.0624 = 2.18$$



$$P_H = \frac{2.18 + 0.80 \cdot (22.1)}{2} = 32.93 \leftarrow \begin{matrix} k & M_A & M_B & M_R \\ & 8.8 & 281.8 & \end{matrix}$$

$$P_V = \frac{1}{2} (0.72) (11.6) (0.6) = 2.51 \rightarrow \begin{matrix} 3.87 & 9.7 \end{matrix}$$

$$U = \frac{2.18 + 0.72 (25.9)}{2} = 37.56 \uparrow \begin{matrix} 15.12 & 568.02 \end{matrix}$$

$$W = \frac{5 \times 12.45 \times 0.0624 + (0.0624) (12.45 + 5.97) (1.5)}{2} = 4.75 \downarrow \begin{matrix} 24.0 & 114.0 \end{matrix}$$

$$F_H = 39.42$$

$$F_V = 33.81$$

$$257.82 \quad 123.7$$

# TAMS

Job No. 1546-10

Sheet 19 of 23

Project NY'S DAM Insp - GARNERVILLE

Date 6-11

Subject Stability Spillway Section

By JJF

Ch'k. by \_\_\_\_\_

Case I Normal Loading - Without Ice

|             | <u>FV</u>    | <u>FH</u>    | <u>MR</u>      | <u>Mo</u>     |
|-------------|--------------|--------------|----------------|---------------|
| Dead Load   | 82.25        |              | 1128.71        |               |
| Hydrostatic | -17.87       | 15.25        |                | 421.0         |
| EARTH FORCE |              | 14.3         |                | 107.25        |
|             | <u>64.38</u> | <u>29.55</u> | <u>1128.71</u> | <u>528.25</u> |

$$\Sigma M = 1128.71 - 528.25 = 600.26$$

$$\bar{e} = \frac{25.9}{2} - \frac{600.26}{64.38} = 12.95 - 9.32 = 3.62'$$

Resultant location

$$9.32 - 8.6 = 0.72 \quad - \text{OK INSIDE M.O.I. } 1/3$$

$$\bar{p} = \frac{64.38}{25.9} \left( 1 \pm \frac{6 \times 3.2}{25.9} \right) \frac{1000}{144} = 17.26 \pm 12.80 = \left. \begin{array}{l} 30.05 \text{ psf} \\ 4.46 \text{ psf} \end{array} \right\}$$

Friction Factor of Safety

$$\frac{64.38 \tan 35^\circ}{29.55} = 1.53$$

# TAMS

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Project NYS Dam Insp GARNERVILLE

Date 6-11-50

Subject Stability - Spillway Section

By JTF

Ch'k. by \_\_\_\_\_

Case II Normal Loading - With Ice load

|             | $\frac{F_v}{}$ | $\frac{F_H}{}$ | $\frac{M_e}{}$ | $\frac{M_o}{}$ |
|-------------|----------------|----------------|----------------|----------------|
| Dead Load   | 8225           |                | 1128.71        |                |
| Hydrostatic | -17.87         | 15.25          |                | 421.0          |
| Earth Force |                | 14.3           |                | 107.25         |
| Ice load    | 0              | 5.0            | 0              | 108.1          |
|             | <u>64.38</u>   | <u>34.55</u>   | <u>1128.71</u> | <u>636.25</u>  |

$$\Sigma M = 1128.71 - 636.25 = 492.46$$

$$\bar{e} = \frac{25.9}{2} - \frac{492.46}{64.38} = 7.65'$$

$$\text{Resultant Location} = \frac{492.46}{64.38} - \frac{25.9}{3} = -0.95' \quad \text{No good ends made}$$

$$\bar{p} = \frac{64.38}{25.9} \left( 1 + \frac{6 \times 7.65}{25.9} \right) \frac{1000}{1111} = 21.7 \pm 38.45 \left\{ \begin{array}{l} 60.15' \\ -16.99' \end{array} \right.$$

Friction Factor of Safety

$$\frac{64.38 \tan 35^\circ}{34.55} = 1.30$$

Not acceptable

# TAMS

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Project NYS Dam Inspection - GARNERVILLE

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Subject Stability Spillway Section

By JTF

Ch'k. by \_\_\_\_\_

Case III -  $\frac{1}{2}$  P.M.F.

|             | <u>FV</u>    | <u>FH</u>    | <u>MR</u>     | <u>Mo</u>     |
|-------------|--------------|--------------|---------------|---------------|
| Dead load   | 82.25        |              | 1128.71       |               |
| Hydrostatic | -29.4        | 27.21        | 92.10         | 769.1         |
| EARTH FORCE |              | 14.3         |               | 107.25        |
|             | <u>52.85</u> | <u>41.51</u> | <u>1220.8</u> | <u>876.35</u> |

$$E.M. = 1220.8 - 876.35 = 344.46 \text{ LF}$$

$$\frac{25.9}{2} - \frac{344.46}{52.85} = 6.79'$$

$$\frac{344.46}{52.85} - \frac{25.9}{4} = 0.29$$

$$\bar{p} = \frac{52.85}{25.9} \left( \frac{1 \pm 6 \times 5.93}{25.9} \right) \frac{1000}{144} =$$

Marginal stability  
center 1/2  
14.17  $\pm$  19.5 } 33.67 psi  
-533 psi

Friction Factor of Safety

$$\frac{52.85 \tan 35^\circ}{41.51} = 0.90 < 1.25 \text{ No Good}$$

# TAMS

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Subject Stability - Spillway

By JTF

Ch'k. by \_\_\_\_\_

Case IV PMF

|             | <u>FV</u>    | <u>FH</u>    | <u>MR</u>      | <u>Mo</u>     |
|-------------|--------------|--------------|----------------|---------------|
| Dead Load   | 82.25        |              | 1128.71        |               |
| Hydrostatic | -52.81       | 30.42        | 123.70         | 857.82        |
| Earth Force |              | 14.3         |                | 107.25        |
|             | <u>49.44</u> | <u>44.72</u> | <u>1252.41</u> | <u>965.07</u> |

$$\Sigma M = 1252.41 - 965.07 = 287.35$$

$$\bar{e} = \frac{287.34 - \frac{25.9}{4}}{49.44} = 0.42$$

No good outside middle 1/2

$$\bar{p} = \frac{49.44}{25.9} \left( 1 \pm \frac{6 \times 6.63}{25.9} \right) \left( \frac{1000}{144} \right) = 13.25 \pm 2.28$$

$$\begin{aligned} & 33.58 \text{ psi (top)} \\ & - 7.03 \text{ psi (bottom)} \end{aligned}$$

Friction Factor of Safety

$$FFS = \frac{49.44 \tan 30^\circ}{44.72} = 0.78 < 1.00 \text{ No good}$$

# TAMS

Job No. 1546  
 Project NYS Dam Inspection - GARNERVILLE  
 Subject Stability Analysis - Spillway

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 By JJF  
 Ch'k. by \_\_\_\_\_

## Case II - Normal loading

Hydrodynamic Force =  
 Dynamic Force - BIRTH  
 - Dead  
 $0.05(82.25) \times 11.9$

8.7 KF (see Sh. 12)  
 3.4 KF  
48.93 KF  
 61.03

|              | <u>FV</u>    | <u>FH</u>    | <u>MR</u>      | <u>MO</u>     |
|--------------|--------------|--------------|----------------|---------------|
| Dead Load    | 82.25        |              | 1128.71        |               |
| Hydrostatic  | - 17.87      | 15.25        |                | 421.0         |
| EARTH Force  |              | 14.3         |                | 107.25        |
| Hydrodynamic |              | 0.98         |                | 8.7           |
| Dynamic      |              | 4.58         |                | 52.33         |
|              | <u>64.38</u> | <u>35.11</u> | <u>1128.71</u> | <u>589.28</u> |

$$EM = 1128.71 - 589.28 = 539.43$$

$$\frac{25.9}{2} - \frac{539.43}{64.38} = 4.57$$

$$\frac{539.43}{64.38} = 8.37$$

$$- 6.47$$

$$\hline 1.89$$

OK - inside middle 1/2

$$\bar{P} = \frac{64.38}{25.9} \left( 1 \pm \frac{6 \times 4.57}{25.9} \right) \frac{1000}{144} = 17.26 \pm 18.27 \left. \begin{array}{l} 35.53 \text{ pr} \\ -1.01 \text{ pr} \end{array} \right\}$$

## Friction Factor

$$\frac{64.38 \tan 35^\circ}{35.11} = 1.28 \quad \text{OK}$$

REFERENCES

APPENDIX F

## References

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